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Handbook of Counting Tubes

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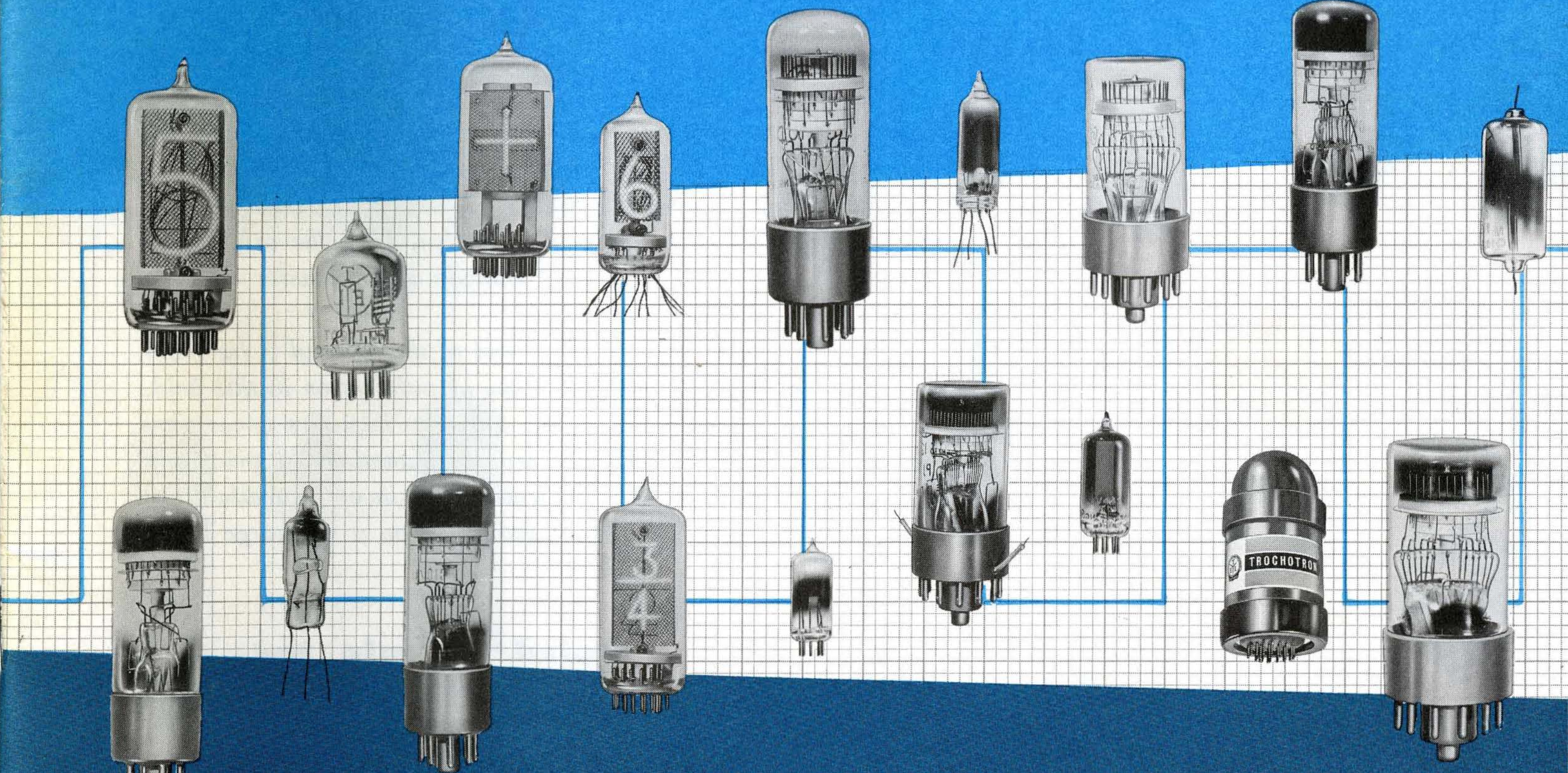

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VOLTAGE REFERENCE TUBES
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FOREWORD

This Manual has been compiled for those in the Electronic, Computer and Control Engineering fields who are interested in reliable components for cold cathode counting. It presents a complete discussion of design criteria based upon tubes manufactured by Etelco, Ltd., the originators of cold cathode glow transfer devices.

The list of references included at the end of the Manual is far from complete and only indicates the scope of publication in this field. Baird-Atomic and its representatives would welcome inquiries concerning special applications of these tubes and will provide quotations of price and delivery on request. An applications engineer is available at Baird-Atomic for consultation on a no-charge basis.

Baird-Atomic, Inc.

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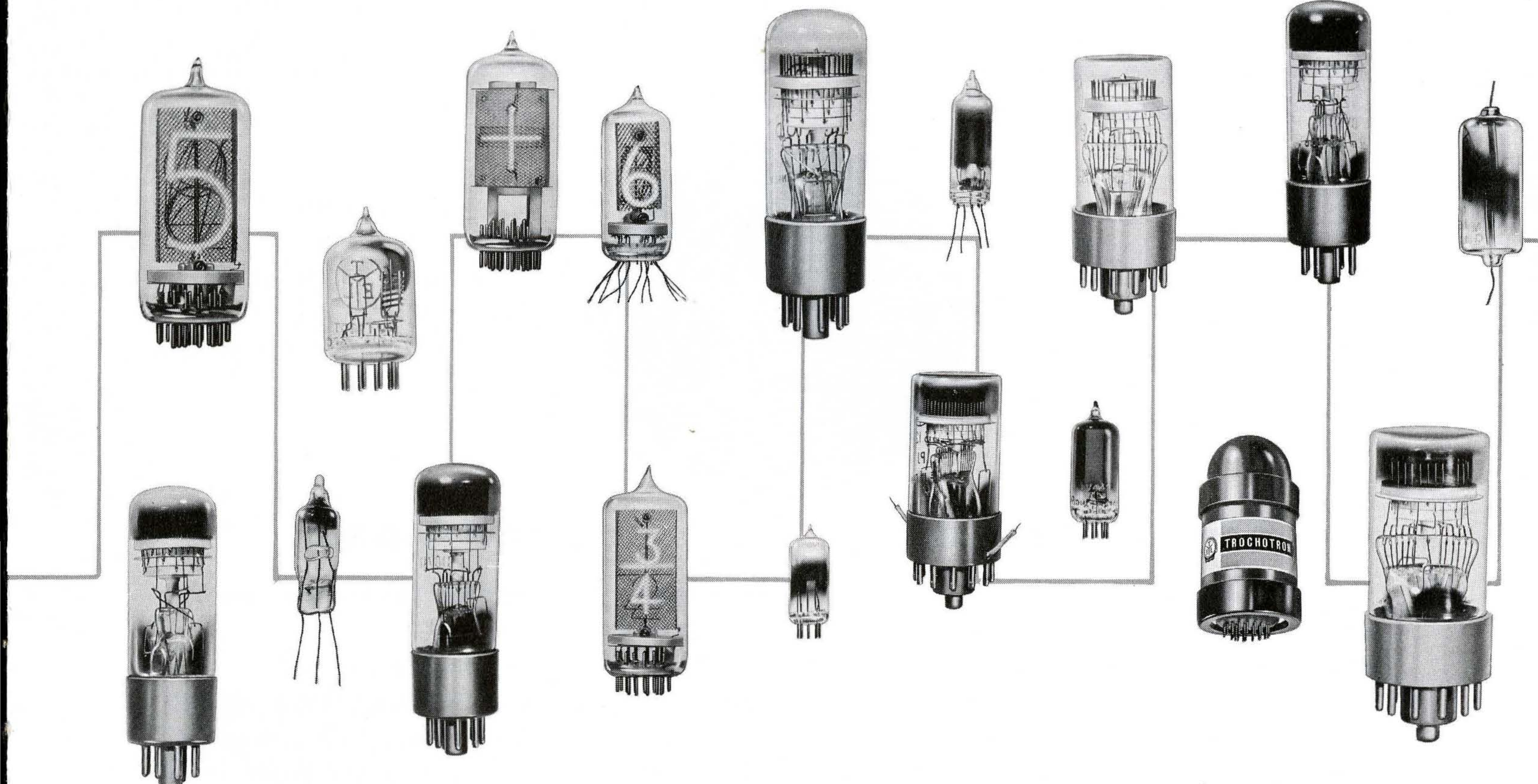

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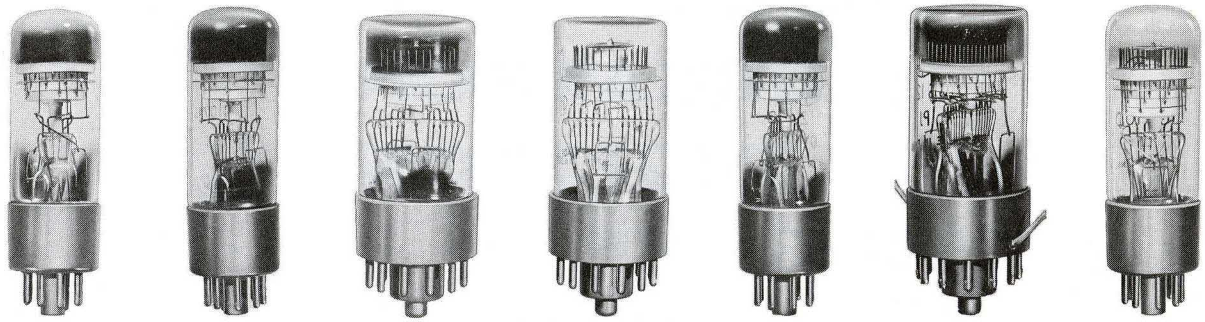
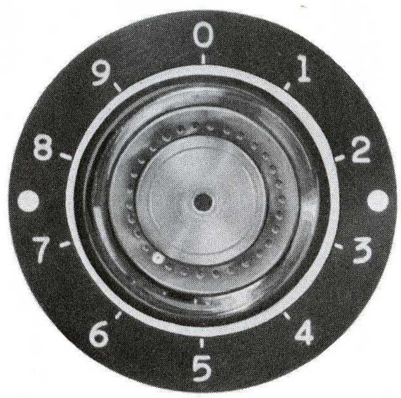


GC10B	GC10/4B	GS10C/S	GS10D	GC12/4B	GS12D	GC10D
0–4K cps 1 Output Cathode 10 Count	0–4K cps 4 Output Cathodes 10 Count	0–4K cps 10 Output Cathodes 10 Count	0–20K cps 10 Output Cathodes 10 Count	0–4K cps 4 Output Cathodes 12 Count	0–4K cps 12 Output Cathodes 12 Count	0–20K cps 1 Output Cathode 10 Count Single Pulse



APPLICATIONS

Simple circuits can be used with the Dekatron tubes to accomplish tasks such as:

Totalizing To register a precise total count from most types of mechanical, photoelectric, electromagnetic, or electronic detectors.

Sorting To trigger many types of batching and packaging mechanisms at a preset count.

Programming To schedule a sequence of operations as in data-processing or automation.

Slow Speed Special Computing To solve specific mathematical equations using simple, inexpensive circuitry.

Controlling To monitor and control selected variables such as length, r.p.m., time, degrees of arc, etc.

ADVANTAGES

Reliable A product proven over ten years for precise measurement.

Fast Up to 20,000 counts per second

Simple Minimum maintenance due to simplified circuitry. No auxiliary readout required.

Economical Low current requirements mean low operating costs.

Reversible Most Dekatron tubes can be used for subtraction as well as addition with suitable circuitry.

Long Life Up to 100,000 hours of continuous operation.

Compact Can cut chassis space as much as fifty per cent due to fewer required components.

dekatron® tubes

GENERAL DESCRIPTION

The Dekatron is a multi-cathode glow tube which can count at rates up to 20,000 counts per second. Electrical impulses introduced to the tube cause a glowing spot to move successively around the cathodes set on its periphery, one move per impulse received. Since outputs can be taken from as many as 12 cathodes, the Dekatron can be used for electronic switching, frequency division, timing, and an increasing number of other applications. The applications section of this Handbook gives some examples of these. Its rugged construction, low power requirements and simple circuitry combine with the perfection of its design over a number of years to make it an unusually reliable component.

nomenclature

All tube types are denoted by a group of letters, followed by a number and a final letter. The first letter gives a general description of the tube, i.e., G = Gas-filled.

The second letter, or group of letters, indicates the class of tube.

Thus: — C = Counter
D = Diode
TE = Tetrode
T or TR = Triode
S = Selector
R = Register

The number that follows these letters refers to a significant characteristic of the tube. For example, in counters, selectors and registers it indicates the number of index cathodes; in diodes and voltage stabilizers, the running voltage; and in trigger tubes, the nominal striking voltage of the trigger electrode.

Where a counter has more than one cathode brought out to its individual pin on the tube base, a second figure separated from the first indicates the number of these cathodes, e.g., GC10/4B.

The final letter indicates the method of connection to the external circuit and also gives the order of development.

A B C D = Phenolic base
M P Q = 7-pin miniature base
W X Y = Wire ended
T = 9-pin miniature base

construction

Taking a representative example, the GC 10B Dekatron can be considered as 30 identical rod-shaped cold-cathode diodes in one envelope, arranged around one circular disc anode. Ten of the electrodes are designated cathodes, ten as "first guides," and ten as "second guides." Nine of the cathodes are internally connected; the tenth, brought out to a separate connection in the base of the tube, is the output cathode. All ten first guides are connected together, as are the second guides. As illustrated in Figure 1, the cathodes, first guides and second guides are intermeshed in cyclic order. Aside from the GC10D single-pulse Dekatron, the differences between the glow tubes are based on the number of cathodes from which outputs can be taken and on the type of gas with which the tube is filled.

In order to insure the mechanical accuracy and uniformity of the electrode spacings, the tube is completely jig-assembled, resulting in an accurate and rigid 30-electrode unit. A great deal of attention is paid to the initial and final freedom from contamination of the electrodes. Moreover, the purity and accuracy of the gas filling is carefully controlled. As a result of these precautions, the major determining factor in the life of these tubes is proper care and correct circuitry.

Cathode Arrangement of a Decade Glow Tube

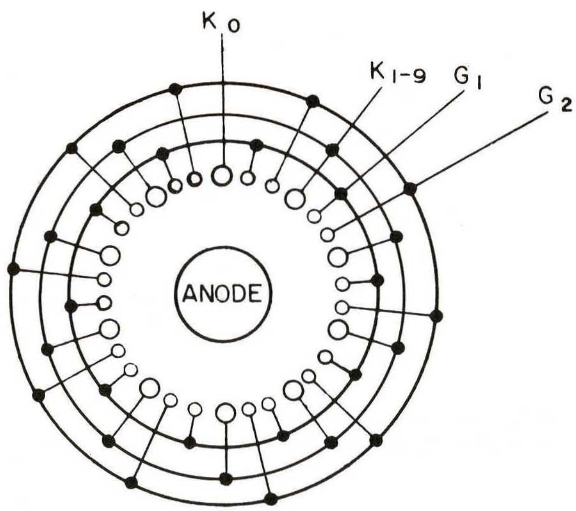


FIG. 1

establishing the glow

The three factors that influence the initial breakdown of the anode-cathode path are photons of light, cosmic rays and B+ supply voltage. In complete darkness, photons are absent, and ignition waits until a cosmic ray of sufficient energy strikes a cathode. Where the supply voltage is high, a low-energy ray will cause ignition, but at the minimum voltage quoted, only a high-energy ray will initiate breakdown, and several minutes may elapse between turning on the voltage and establishing a glow. Light on the cathodes has a similar effect as cosmic rays, and ignition is practically instantaneous. Once the discharge is established, light has no further effect on tube performance.

The glow current is determined by the following equation:

$$I_a = \frac{E_B - E_T}{R_a + R_e}$$

where E_B = supply voltage
E_T = running voltage of tube
R_a = anode resistor
R_e = effective resistance between cathode or guide and B^-.

There is no maximum value to E_B; it is the Dekatron current which must be kept between limits. Below the minimum recommended current the tube has a negative characteristic and is unstable. High currents cause selective sputtering of the cathode material and the life expectancy is reduced.

output

A resistor is wired in series with the output cathode so that the glow current will raise its potential, giving a positive voltage output. Several factors limit the value of this resistor and the resulting output voltage, and are detailed in the following paragraphs.

(1) Multiple glows will occur in the tube if a cathode resistor is not much smaller than the anode resistor.

(2) The increase in total circuit resistance produced by the cathode resistor may reduce the tube current below the minimum limit.

(3) If the output cathode becomes more than about +35 volts, the glow may jump to another cathode; a 40-volt signal may be obtained by biasing the output cathode at —20 volts with respect to the common cathodes, and allowing it to rise to +20 volts.

(4) For longest life, not more than 85% of the anode current should flow into the selected cathode; the remaining 15% serves to keep the adjacent guides in a receptive condition. Where

the required output is less than the maximum, the value of the resistor must be obtained experimentally, but approximates:

$$R_K \cong \frac{V_K}{0.85 \cdot I_a}$$

glow transfer

The plasma surrounding a glowing electrode reduces the ignition voltage of both adjacent gaps to a value only slightly higher than the normal tube gas drop. If a grounded cathode is glowing, and an adjacent guide is made some 20 volts negative, the discharge will commence to transfer to the negative guide. As time passes, the proportion of anode current flowing to the negative guide increases, and eventually the whole discharge is received by the guide. The time for this transfer is in the order of 100 microseconds for a neon-filled tube but, by increasing the potential difference between donor and acceptor electrodes to about 60 volts, the time is shortened to 25 microseconds in a new tube. However, during the life of the tube, the time to transfer increases exponentially with time, tending to a value of 80 microseconds. This latter figure should be used in circuit design.

It is assumed in the preceding paragraph that the other adjacent guide does not become negative. In many drive circuits this is not the case, and the second guide does become negative before the discharge has stabilized on the first guide. Under these conditions the glow experiences opposing attractive forces, and it is the difference between the voltages on the first and second guides which is effective in transferring the glow.

In the design of drive circuits, the effect of the resistance between guide and ground is most important. When the tube current flows into a guide and through the guide leak resistor to B^-, a potential difference is produced across the leak resistor which opposes the drive voltage. Once an electrode receives more than half of the total discharge current, the glow establishes itself under normal circuit conditions. If a very large voltage pulse is applied to a guide, a cathode-to-guide discharge occurs which rapidly destroys the surface of the cathode now acting as an anode. The maximum voltage is about 140, and if 20 volts is allowed for positive bias (see "Drive Circuits") a —120-volt signal is available. Sixty volts is required for rapid transfer, leaving a maximum of 60 volts which can be dropped across the guide leak resistor. If the electrode requires 180 microamperes to establish the glow, the absolute maximum allowable value for the guide leak is 60/180 μA, i.e., 300 K ohms. Some circuits have been designed which parallel a very high guide resistor with a capacitor, so that the discharge is established by the charging current of the capacitor. This is permissible only when the drive pulse terminates at the time the capacitor becomes charged.

drive circuits

One count requires three glow transfers: cathode to first guide, first guide to second guide, and second guide to cathode. Drive circuits successively convert pulses from the signal source into waveforms on the guide electrodes such that each in turn becomes the most negative.

drive waveforms

It has been stated above that a 60-volt potential difference between electrodes which persists for 80 microseconds causes reliable glow transfer. Some of the most useful waveforms are shown following; pulse rise and fall times are exaggerated.

DOUBLE PULSE DRIVE

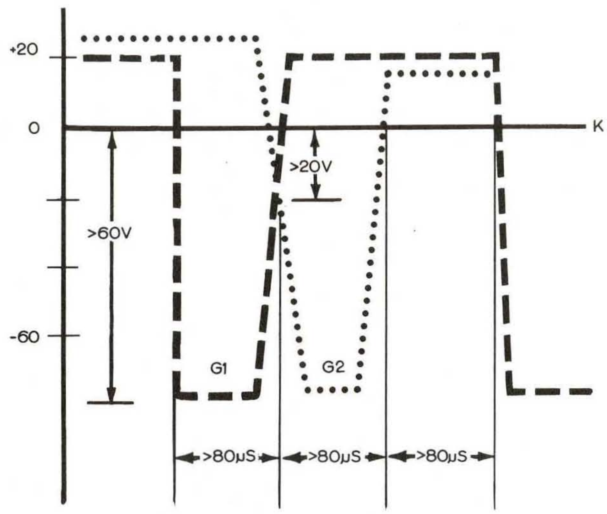
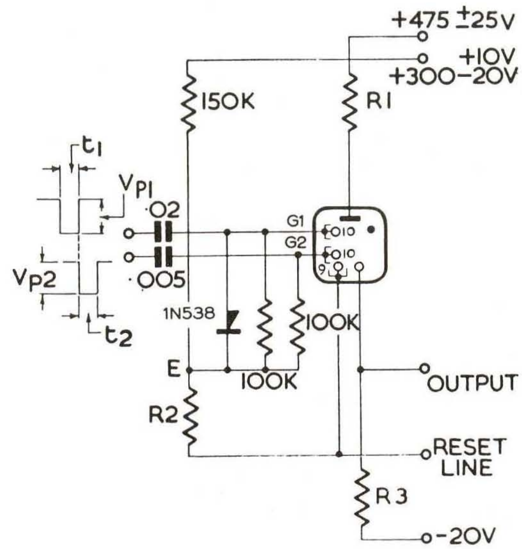


FIG. 2

Paired-pulse Drive for 4 kc/s Dekatron



LK106

	Counters	Selectors
R1	820 kΩ	680 kΩ
R2	10 kΩ	22 kΩ
R3	150 kΩ max.	150 kΩ max.
E	+18 V	+36 V

$V_{P1} = V_{P2} = -80 \pm 10$ V $\quad t_1 = t_2 = > 60\ \mu$S

INTEGRATED PULSE DRIVE

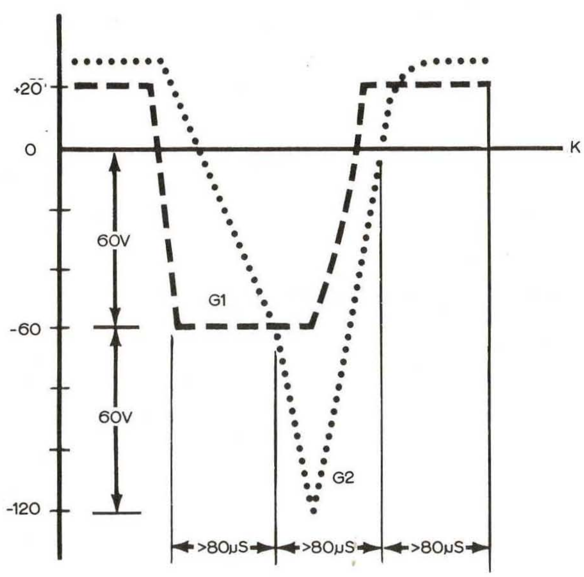
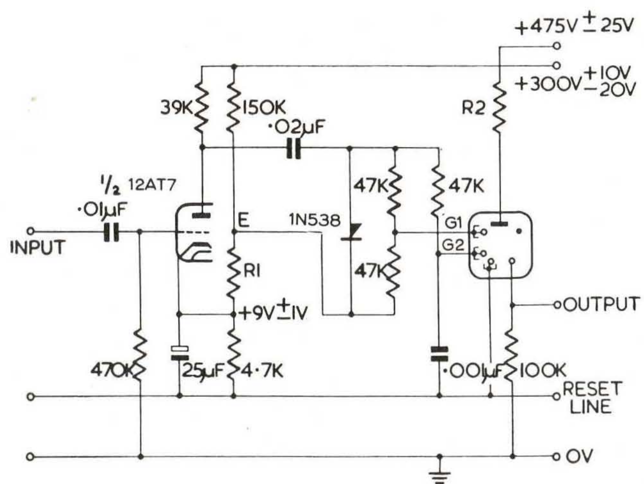


FIG. 3

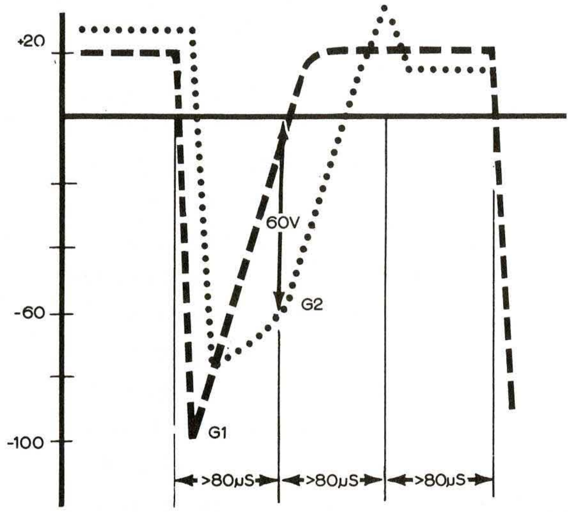
Amplifier for Coupling two Double-pulse Dekatrons



LK109

	Counters	Selectors
R1	4·7 kΩ	15 kΩ
R2	820 kΩ	680 kΩ
E	+18 V	+36 V

TRIGGER TUBE DRIVE



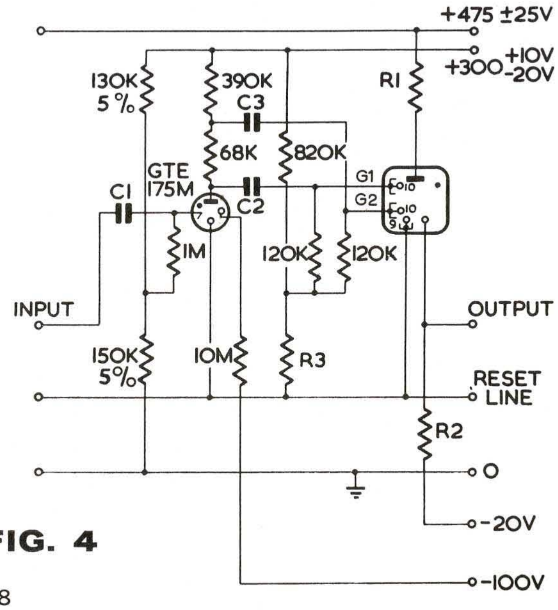


FIG. 4

LK108

Cold-cathode Trigger Tube Circuit for coupling two 4 kc/s Dekatrons (0-500 "carries" per second)

	Counters	Selectors
R1	820 kΩ	680 kΩ
*R2	150 kΩ max.	150 kΩ max.
R3	39 kΩ	47 kΩ

	Input to previous stage	
	Rect. Pulses	Sine Wave
C1	.001 µF	.01 µF
C2	.001 µF	.001 µF
C3	.002 µF	.002 µF

*The cathode load resistor of the previous stage must not be > 150 kΩ

If both guides are biased positively, the adjacent cathode will appear negative at the end of the second guide pulse, and the glow will transfer. The amount of guide bias required is determined by the transfer to the output cathode. Suppose the potential of the output cathode is designed to change from —20 volts to +20 volts when invested with tube current. Also, assume the resistance between the output cathode K_0 and B^- is the same as the resistance between second guide and B^-. At the point of transfer, half the anode current flows to each of these electrodes, so that K_0 is at 0 volts while 20-volt signal is developed across the second guide resistor. Now, in this case, where the first guide has been restored to its original bias potential prior to the transfer being considered, there is only one force acting on the discharge and a potential difference of 40 volts is sufficient to cause transfer. Since 20 volts is developed across the guide circuit, a guide bias of +20 volts is sufficient to produce the potential difference required for glow transfer.

It can be seen that glow transfer in a Dekatron is a smooth, gradual process. The leading edge of the output pulse has a shape complementary to that of the trailing edge of the second guide pulse and, similarly, the trailing edge of the output pulse is very nearly a mirror image of the leading edge of the pulse on the first guide. Since the latter is normally fixed in time, the trailing edge of the output pulse has the least jitter, and is best suited for time reference purposes.

The preceding explanation has been based on the GC10B, but also applies to the GC10/4B, GC12/4B, GS10C/S and GS12D.

It has previously been explained that in the GC10B, Cathode 0 is brought out to an individual base pin, and cathodes 1 through 9 are internally connected. The GC10/4B has individual connections to Cathodes 9, 0, 3 and 5, and the remaining six cathodes are internally strapped together. The GC12/4B has 12 Cathodes of which 11, 0, 6 and 8 have separate base pins, and the remaining eight cathodes are connected.

The GS10C/S and GS12D have separate

electrical connections to every one of their ten or twelve respective cathodes. If an output is not required from every count, the cathodes not giving outputs may be directly grounded. There is no advantage to be gained by connecting the cathode resistors of the GS series to a negative voltage, instead the guides must be biased to a potential which exceeds by a few volts the maximum potential difference produced across the cathode loads by the discharge current.

The GS10D operates at a higher current and is filled with a gas mixture having a shorter deionization time. This gas filling produces less visible glow, but the blue color of the glow photographs better. The method of circuit design is the same, but in order to insure that the anode can follow the changes in guide potentials, anode stray capacitance becomes important, and it is essential to wire the anode resistor directly to the tube socket.

Unlike other Dekatrons, the GC10D requires only one pulse for each count. See Fig. 5. It is similar in appearance to double-pulse tubes, but has three guide electrodes between successive cathodes, instead of two.

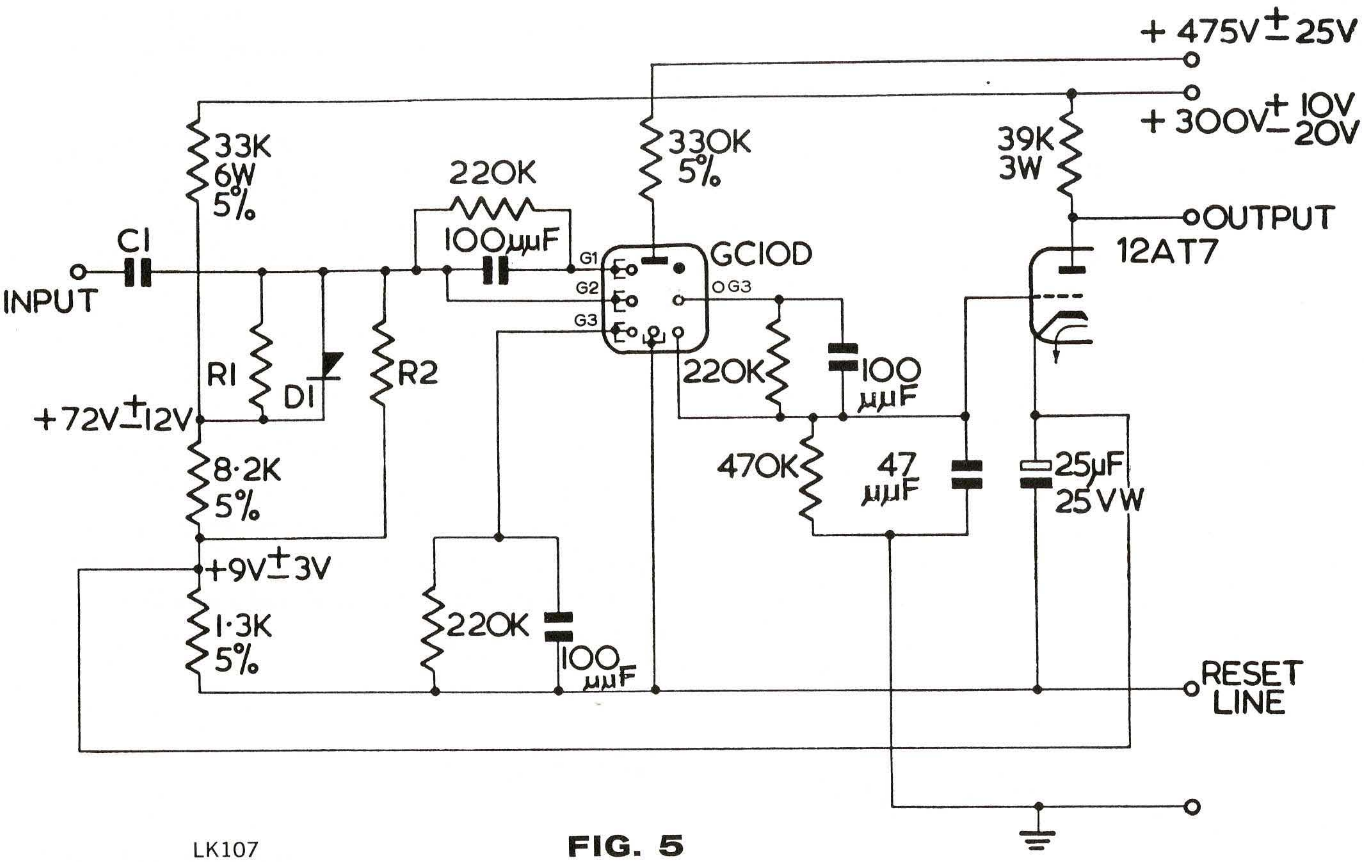
The negative input pulses are applied through a 220K resistor to the first guides, and directly to the second guides. These two groups of guides are normally biased positively with respect to the grounded cathodes. The cathodes are preceded by the third guides, which are connected to ground via a 220K resistor. The receipt of an input pulse transfers the glow from a cathode to the adjacent first guide, and the anode current by flowing through the common first guide resistor, raises the voltage of the guide. When the Potential Difference between first and second guides exceeds the transfer voltage, the glow moves (auto-transfers) to the second guide, where it rests until the input signal is ended. The return of the first and second guides to the positive bias potential moves the glow to the third guide, and again an auto-transfer takes place to the cathode, so completing one count. The rate of change of voltage on the guides is kept to a suitable value by 100 μμF capacitors connected in parallel with the auto-transfer resistors.

reset

At the end of a particular count, it is usually desirable to return the glow on the Dekatron to zero. If the zero cathode is made about 100 volts negative with respect to all other cathodes and guides, the glow jumps across to the zero cathode in approximately 5 microseconds. When the glow invests the output cathode it produces a normal output signal, and it is necessary either to block the "carry" circuits, or to return the units decade to zero and all other decades to 9 and allow the resulting carry to pass through the instrument.

If the output cathode is ac-coupled into the interstage amplifier, all other cathodes and guides can be taken 100 volts positive, and held until the resulting output pulse has passed through the coupling capacitor. On restoring to normal, no carries take place.

GC10D Single-pulse Drive with Coupling suitable for Integrated-pulse Drive LK105



LK107

FIG. 5

Drive	Input		C1	R1	R2	D1
	Duration	Amplitude				
Random pulse	> 25 μS	$145\ V^{+50\ V}_{-12\ V}$	.02 μF	1 MΩ	Not req'd.	1N538
Sine-wave	—	65—100 V r.m.s.	To suit lowest frequency	Not req'd.	100 kΩ	Not req'd.

The grid and cathode of the pulse amplifier are used as a limiting diode for the GC10D output cathode voltage.

effect of ripple on B+ voltage

Consider a GC10B, with a 100-K ohm output and guide resistors. The anode current range is given as 250 to 550 microamperes, with a mean at 400 microamperes. The anode-cathode gas drop is about 190 volts. A nominal B^+ of 462 volts and an anode resistor of 680 K ohms produces 400 microamperes into a grounded cathode:

$$\frac{462 - 190}{680} = \frac{272}{680} = 400 \text{ microamperes}$$

Now, 550μa × 680 K =	374V
Add the tube drop	190V
Total	564V

Therefore, the B^+ could have a peak voltage of 564 volts without damaging the tube.

The lowest current occurs when the glow is investing the output cathode:

250μa × (680K + 100K) =	195V
Add the tube drop	190V
Total	385V

This would be the minimum instantaneous voltage, giving a permissible peak-to-peak ripple of 564 — 385 = 179V; i.e., 64 volts rms.

However, when the anode current changes by 300 microamperes, the output cathode current changes by about 85% of this (i.e., 250 microamperes). This means a change in output voltage of 25 volts (i.e., 8.8 volts rms) with a 100K load. A condition such as this may affect the carries into the next stage, causing some spurious carries and missing some true ones.

input/output durations

The recommended integrated pulse drive, at the maximum speed of 4 kc, or 250 microseconds per count, applies the original 80-microsecond pulse to guide G_1, a delayed 90-microsecond pulse to guide G_2, and allows the glow to dwell on a cathode for 80 microseconds. When this is the output cathode, the output pulse is 80 microseconds long and, since this is the input pulse to the next stage, the input is again an 80-microsecond pulse. Note that any lengthening of the pulses on either G_1 or G_2 means a shortening of the output pulse duration (assuming a constant repetition rate), and may leave insufficient time to drive the next stage.

This point must be considered when designing a counter containing both high-speed and standard Dekatrons. For example, a GC10D operating at 20 kcps gives an output pulse about 20 microseconds long every 500 microseconds. So, although the repetition rate of 2 kcps is low enough for a GC10B, the 20-microsecond pulse duration is insufficient. A second GC10D gives 475-microsecond pulses every 5 milliseconds, and, can be coupled directly to a GC10B. Alternatively, the 20-microsecond pulse can be stretched by a capacitor and diode, as is done in the GC10D Drive Circuit where the grid and cathode of the triode act as a diode.

tube life

The most sensitive and important test of tube life is the minimum length of time required to drive the glow from one element of a Dekatron tube to the next. It was found that the operating characteristics of all Dekatrons change with the operating age of the tube in question according to the following curve.

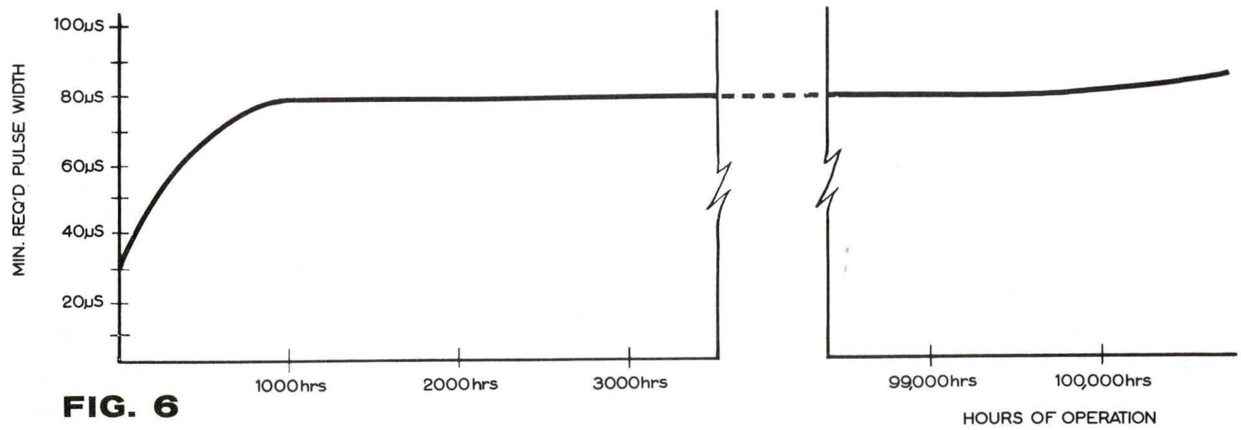


FIG. 6

typical life curve of a 4 KCPS dekatron operating under optimum conditions

The scale of this curve is only approximate but illustrates the fact that a new tube will require as low as 25 µsec to transfer from element to element. This minimum time duration increases until 70-80 µsec is required to complete one transfer, say from a cathode to the next first guide. An 80 µsec pulse is required until approximately 80,000 to 100,000 hours of use under optimum conditions, when the minimum transfer time again begins to increase. The figure of 80 µs (25 µsec for 20 kcps tubes) is quoted in the tube specifications. By way of definition, end of life is reached when the tube no longer operates according to these specs, i.e. when a pulse longer than 80 µsec (or 25 µsec) is required to step the glow from one position to the next.

The optimum conditions mentioned above are met when the tube is permitted to circulate evenly, counting perfectly equal 80 µsec pulses of uniform amplitude. Since three transfers are required to move the glow from one index cathode to the next (K_0 to G_1, G_1 to G_2, G_2 to K_1), the minimum time required for one complete count is 3×80 µsec, or 240 µsec, which corresponds to a maximum counting speed of 4 kcps.

If a pulse shorter than the recommended minimum time were applied to the tube, the glow would begin a transfer to the next element but would return to the original position as soon as the pulse was removed. The glow will then "stick" on that cathode no matter how many times the pulse is repeated or how much its amplitude is increased. Therefore "sticking" may be overcome only by increasing the duration of the driving pulse.

The most adverse condition that a Dekatron might encounter is that which requires the glow to remain on one cathode and never to move. In this case the end of life, as defined above, will occur when the tube has been required to register a single count for 2000-3000 hours.

A tube which has been caused to operate under these adverse conditions can be "revitalized" in a sense by causing it to recycle rapidly for an hour or so. It is not possible to define this effect quantitatively, although there will be a notable improvement in tube life. For this reason, it is advantageous to rotate similar tubes in a cascade counter, so that a tube used in the millions digit, for example, is called upon to operate in the units digit.

Shelf life of this tube is unlimited as long as they are not subjected to temperatures higher than 80°C. When a tube is caused to glow, this temperature limit does not exist, but otherwise storage at high temperature shortens tube life considerably.

In summary, the most important design considerations as far as tube life is concerned are as follows:

1. The drive pulses should be as uniform and as wide as the application will permit.
2. The tubes in a multi-decade scaler should be interchanged or caused to circulate

rapidly as often as practical. The harder cold cathode tubes are caused to work, the longer they will last.

3. The tubes should be stored at moderate temperatures.
4. Anode current should be maintained within the prescribed limits in order to avoid sputtering of the cathode material.

applications

Dekatrons are counting tubes. The GC10B provides a visible indication of the digits 0 through 9 on the surrounding face or bezel. For every 10 input pulses, it produces an output signal for the entire time the glow dwells on the cathode corresponding to the 0 digit. The output pulse can be amplified and used to drive another tube to form a multi-decade counter with built-in visual read-out. Visual read-out is a distinct and obvious advantage of this type of counter. A Dekatron counter requires only a few components, very little wiring, and is much less expensive than Eccles-Jordan stages requiring auxiliary visual read-out circuitry.

Other Dekatron applications are the counting of pulses from nuclear disintegrations or, in conjunction with a photocell, the counting of articles on a conveyor belt. Using a perforated disc and photocell system, the length of material can be measured by passing it through rollers coupled to the measuring disc. As an alternate method, a synchronous clock motor shaft can be coupled to the rollers and pulses taken from the electrical terminals, the number of pulses per revolution being equal to the number of poles on the motor. Rotary movement can be indicated in the same way; the use of 12-way tubes in this application makes it convenient working to a base of 6° for conversion from seconds to minutes of arc, and minutes to degrees.

For time determinations, a frequency standard can be divided down to produce output pulses at practically any desired submultiple of the input frequency. Another usage is to apply the standard frequency to the Dekatron through a gate, and an event can be timed by opening and closing the gate. With a 10-kcps source, each count is 0.1 millisecond and the final result is accurate to $^{+0}_{-0.1}$ millisecond. It is possible to combine the output signal from cascaded tubes such that a "graduated ruler" is produced on an oscilloscope, simplifying time measurements. The largest application of this nature is probably to welder timers where welds are required to be a fixed number of cycles in length.

A frequency meter can be constructed by feeding a standard frequency to a scaler to obtain output pulses that occur at a fixed repetition rate; for example, every second. Alternate output pulses open and close a gate which connects the unknown input signal to another scaler. Therefore, the number of cycles of the signal frequency which occurs in one second is counted.

"Selector" Dekatrons having electrical outputs from all cathodes are built easily into "batch" counters. When the desired number of articles has passed, a deflector re-routes the goods into a new container, and the counter is simultaneously reset. Several output signals can be obtained from the same counter, so that when the count approaches the preset figure, a slow-down signal can be given to the machine.

A selector Dekatron can be used as a sequence switch producing an output from each cathode in turn. By combining a sequence switch with two or more batch counters, multiple counting can be accomplished; e.g., zipper teeth and the space between.

Special circuits are available for intermediate storage where the total of input pulses received simultaneously from several sources is required. A Dekatron is used as a temporary storage element at each input, and each element is then emptied into the total counter in sequence.

Most Dekatrons are reversible and will permit automatic overshoot correction of a heavy work table in milling, grinding, drilling or similar machining operations. In this case, the tubes may count pulses from magnetic pickups which detect rotation of the table drive gears. It is possible to correct position to an extremely high degree of accuracy by counting the optical fringes which are detectable by some type of photoelectric device, and which are produced by interference patterns.

DIGITRON

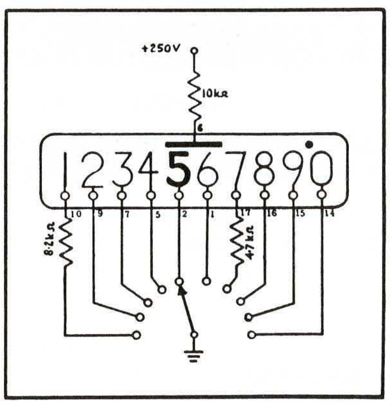
Ⓣ TRADEMARK

The Digitron is a cold cathode register tube which permits a brilliant in-line readout for the most accurate presentation of data. The chosen character may be illuminated by grounding the proper pin connection through appropriate electronic or mechanical switching circuits. Alternatively, the tube may be used to display the state of count of a ring of cold cathodes or thermionic tubes, by taking the cathodes of the register tube to the anodes of the tubes comprising the ring. The tubes are ideal for use in control consoles, desk equipment and remote indicator panels where the state of count at selected control tubes would be monitored.

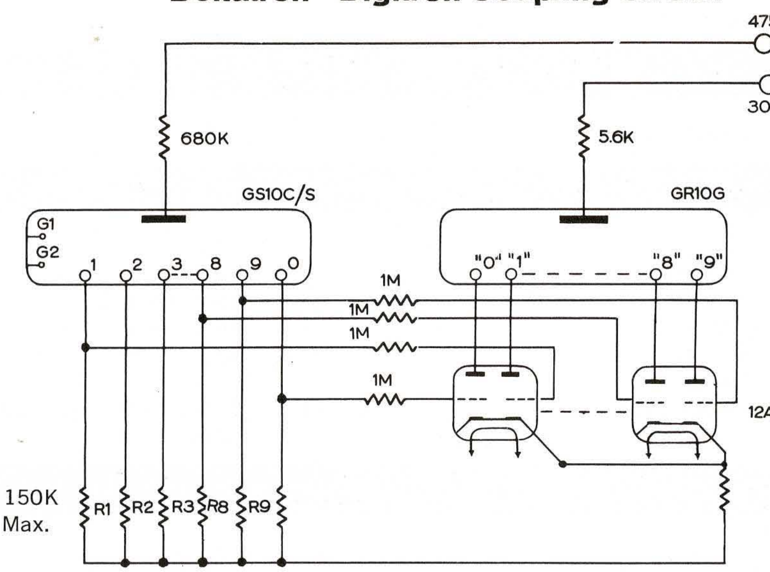
The cathode characters are stamped from nickel sheet and mounted securely within an expanded metal screen anode. This construction has proven to be more shock-resistant and rugged than conventional electro-plated characters.

The type GR10H Digitron may be used in both AC and DC applications. The highly rugged construction and end-view readout capability contribute to the versatility of this line of register tubes.

Mechanical Grounding Circuit



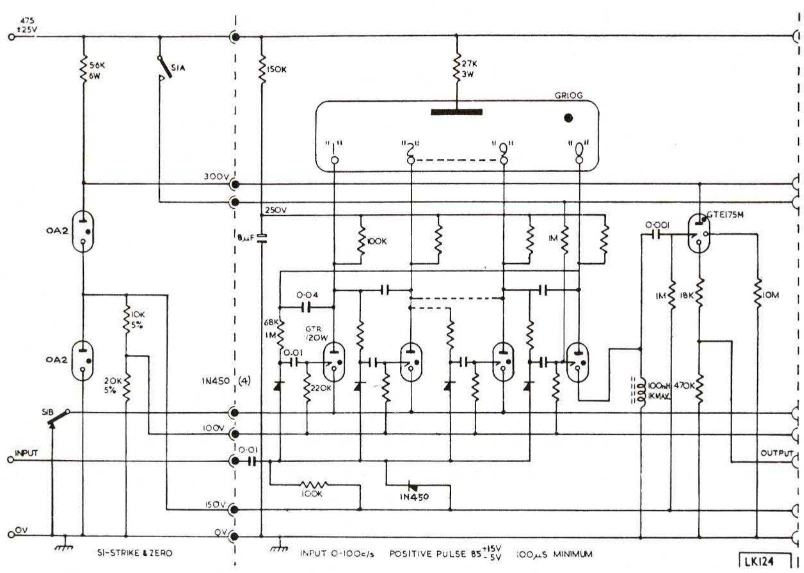
Dekatron · Digitron Coupling Circuit



R1 — R10 = 56K — 150K
Min. Max.

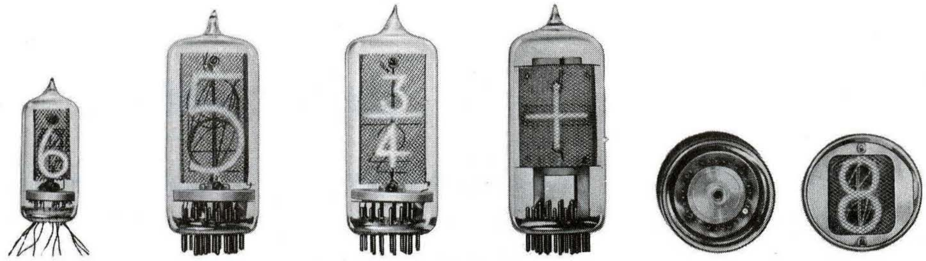
FIG. 7

Trigger Tube Ring Counter incorporating Digitron Readout



Baird-Atomic, Inc.

DIGITRON®
TUBE SPECIFICATIONS



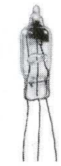
TYPE	GR10W	GR10G	GR4G	GR2G	GR10A	GR10H
Presentation	0-9	0-9	1/4, 1/2, 3/4, 1	+, −	Dekatron Type	Tentative 0-9
LIMIT RATINGS						
Max. cathode current	4ma	9ma	1/4, 1/2, 3/4 = 7ma 1 = 5ma	+ = 5ma − = 3ma	250μa	
Min. cathode current					50μa	
Min. anode to cathode voltage necessary to insure breakdown	220V	220V	200V	180V	129V	140-150V
Max. voltage across tube and 500KΩ resistors to ensure tube extinguishes					150V	
CHARACTERISTICS						
Normal running voltage	160V	180V	170V	168V	108V at 60μa	140V at 2ma
RECOMMENDED OPERATING CONDITIONS					**NB1**	
DC supply voltage	220V	250V	250V	250V	360V	210V 250V
Anode resistor	18KΩ	10KΩ	12KΩ	Not req'd.	680KΩ	30KΩ 56KΩ
Unsmoothed rectified halfwave 60 cps AC	200-220V r.m.s. / 220-250V r.m.s.	200-220V r.m.s. / 220-250V r.m.s.	200-220V r.m.s. / 220-250V r.m.s.			
Anode resistor	27KΩ / 47KΩ	12KΩ / 18KΩ	12KΩ / 18KΩ			82KΩ } NB 2
Pure AC						240V } NB 2
Cathode equalization resistors	Cathode 1-33KΩ	Cathode 1-8.2KΩ Cathode 7-4.7KΩ	Cathode 1-10KΩ	+cathode-15KΩ −cathode-27KΩ		
PIN CONNECTIONS NOTE: All unused pins to be left unconnected						
Pin or Lead 1	Cathode 1	Cathode 6	....	....	Cathode 1	Cathode 3
2	Cathode 2	Cathode 5	....	....	Cathode 0	Cathode 2
3	Cathode 3	....	....	....	Cathode 9	....
4	Cathode 4	....	....	....	Cathode 8	Cathode 0
5	....	Cathode 4	....	....	Cathode 7	Cathode 7
6	Cathode 5	Anode	Anode	Anode	Cathode 6	Cathode 8
7	....	Cathode 3	Cathode 1/2	....	Cathode 5	....
8	Cathode 6	....	Cathode 3/4	....	Cathode 4	AC Anode
9	....	Cathode 2	....	....	Cathode 3	....
10	Cathode 7	Cathode 1	....	−Cathode	Cathode 2	Cathode 6
11	Cathode 8	....	....	....	....	Cathode 5
12	Cathode 9	....	....	....	Anode	DC Anode
13	Cathode 0	....	....	....	....	Cathode 1
14	Anode	Cathode 0	....	+Cathode	....	Cathode 9
15	....	Cathode 9	Cathode 1	....	....	Cathode 4
16	....	Cathode 8	....	....	....	....
17	....	Cathode 7	Cathode 1/4	....	....	....
Base required	Flying leads	SO-42	SO-42	SO-42	SO-22	SO-61

NB 1 To insure correct operation the cathode potential must change by a voltage V_o where: $V_o > V_s - V_x > 129\text{-}105$ i.e., 24V
V_s = striking voltage V_x = extinction voltage

NB 2 Connect 1 megohm resistor between AC and DC Anode (Pins 8 and 12) during AC operation.

GENERAL NOTE: A cathode left floating will assume some potential between that of the anode and the glowing cathode.

TRIGGER TUBES

REMARKS	GTE175M NB2	GTR120W NB3 & 4 & 6	GDT120T NB5
	Trigger tetrode designed for Dekatron coupling circuits and as a general purpose trigger tube.	Trigger tube, an inexpensive sub-min. tube especially designed for computer applications.	Primed trigger tube, a high current inexpensive trigger tube suitable for operation in poor light conditions.
LIMITS			
Maximum anode volt. to prevent self ignition in all tubes	V_T +173V V_A +310V	V_T 0V V_A +310V	V_T 0V V_A +400V
Minimum trig. volt. to cause trig. breakdown in all tubes	V_A +300V V_T +183V	V_A +290V V_T +170V	V_A +315V V_T +155V
Max. trigger to cathode voltage at which breakdown will not occur	V_A +300V V_T +173V	V_A +310V, V_K 0V, V_T +110V	V_A +315V, V_K = 0V, V_T = 100V
Max. trigger to anode volt.	+200V	V_A +150V, V_K 0V, V_T −100V	V_A = 315V, V_K = 80V, V_T = 0V
Min. trig. to cath. current to cause transfer in all tubes	(V_A +300V) 100μa	(V_A +290V) 250μa nominal	
Min. trig. to cath. current to cause trans. with 100$\mu\mu$f between cath. and trig.	(V_A +300V) 8μa		
Max. cathode current	Peak 6ma Mean 3.5ma	9ma	60ma peak (100m sec duration)
Min. cathode current		3ma	5ma
CHARACTERISTICS			
Anode running voltage	150V±5V at 2.5ma	95V–140V at 4.5ma	94–130V
Trigger running voltage	135V nominal	73V nom. at 500μa	
Deionization time	600μs max.	3ms	10ms max. at 25ma
Minimum current at which all tubes will remain conducting	200μa		
Min. anode res. to cause extinction in all tubes	R_A res. = 470K (V_A = 310V) 680KΩ		
Ionization time		V_T pulse +200V 90μsec	1ms at V_T = 175V pulse
Light striking voltage			315V max.
Auxilliary cathode current (aux.K returned to a min. of −95V via 10MΩ)	25μa nom.		
RECOMMENDED OPERATING CONDITIONS		**Normal Room Illumination**	
Anode Supply Voltage	280–310V	180–310V	315V
Anode to Cathode Current	2.5ma	4.5ma	25ma
Trig. bias with respect to K		+100V R_T 220KΩ	+80V R_T 100KΩ
Trig. leak less than 470KΩ	160V Max.		
Trig. leak greater than 470KΩ	170V Max.		
Min. pulse required for operation	+25V (100μs)		
Anode Load Res.		47KΩ	8.2KΩ
Minimum trig. coupling capacitor (trig. res. > 200K)		150 $\mu\mu$F	
			Light cathode to be con. via 10M to 0V Light anode to be con. via 10M to +315V
MECHANICAL DATA			
Mounting Position	Any	Any	Any
Weight	6.5g nom.	2.2g nom.	
Base	7 pin connections 1, 2 Trigger T 3, 4 Cathode K 5 Do not connect 6 Auxilliary cath. K_2 7 Main anode A	3 flying leads 1 Anode 2 Trigger 3 Cathode	9 pin connections 1 Anode 2 Do not connect 3 Trigger 4, 5 Cathode 6 Do not connect 7 Light cathode 8 Light anode 9 Anode

1. During first 3000 hrs. of operating life the trigger breakdown voltage will not drift outside the limit ratings specified above.
2. This tube must not be enclosed in a metal screen or can.
3. The impedance of the trigger in a conducting tube has a maximum value when the trigger cathode voltage is approximately 65V.
4. If tubes stand in the off condition for 150 hours or more, self ignition may occur at anode voltages above 280V, unless a current of 3ma is passed through all tubes for at least 1 second before commencing normal operation of the circuit.
5. Tubes may exhibit jumps of up to 20V in operation.
6. Tubes may exhibit jumps of up to 10V in operation.

DEKATRON
TUBE SPECIFICATIONS

	GC10B	GC10D	GC10/4B	GC12/4B	GS10C/S	GS10D	GS12D	GS10G	GS10K
GENERAL SPECIFICATIONS								Tentative	Tentative
Scale	10	10	10	12	10	10	12	10	10
Count Rate	0–4k cps	0–20k cps	0–4k cps	0–4k cps	0–4k cps	0–20k cps	0–4k cps	0-10k cps	0-10k cps
Base Required I.O. — intermediate octal SO-22 — duodecal w/cap SO-42-26 pin socket	I.O.	I.O.	I.O.	I.O.	SO-22	SO-22	SO-22	SO-42	
Remarks	Scale-of-ten counter	Counter for single pulse operation	Bi-directional computing	Bi-directional computing	Bi-directional selector	Bi-directional selector	Bi-directional selector	Designed for simplified bi-directional applications	Selector for single-pulse high current operation
LIMIT RATINGS									
Maximum Count Rate:									
sine wave drive	4k p.p.s.	....	4k p.p.s.	4k p.p.s.	4k p.p.s.	20k p.p.s.	4k p.p.s.	10k cps	10k cps
rectangular pulse drive	4k p.p.s.	....	4k p.p.s.	4k p.p.s.	4k p.p.s.	10k p.p.s.	4k p.p.s.	10k cps	10k cps
Maximum count rate: any wave shape	....	20k p.p.s.	....	....	....	....	....		
Maximum total anode current	550μA	1.2ma	550μA	550μA	550μA	900μA	350μA	900μA	2.0ma
Minimum total anode current	250μA	700μA	250μA	250μA	250μA	700μA	190μA	700μA	1.5ma
Minimum anode supply voltage	350V	420V	350V	350V	400V	440V	400V	440V	480V
Maximum potential difference between guides and cathodes	140V	180V	140V	140V	140V	180V	140V	180V	....
Output cathode load	150KΩ Max.	82KΩ	150KΩ Max.	150KΩ Max.	150KΩ Max.	....	270KΩ Max.	....	....
Maximum output pulse available with:									
150K cathode load resistor	35V	[3]	35V	....	35V @ 4k c/s	....	....	....	....
68K cathode load resistor	....	....	....	....	....	35V	....	35V	....
270K cathode load resistor	....	....	....	....	....	....	35V	....	....
39K cathode load resistor	....	....	....	....	....	....	....	....	>50V
Maximum routing guide resistor	....	....	....	....	....	....	....	22KΩ	....
CHARACTERISTICS									
Running Voltage	191 ± 5V @ 300μA	215V approx. @ 800μA	191V approx. @ 300μA	191V approx. @ 300μA	192V approx. @ 325μA	208V approx. @ 800μA	191V @ 270μA	210V approx. @ 800μA	238V approx. @ 1.5ma
RECOMMENDED OPERATING CONDITIONS									
Anode Current	310μA±20%[1]	800μA[4]	310μA±20%[1]	310μA±20%[1]	325μA±20%[6]	800μA[7]	270μA±20%[9]	725μA[7]	1.5ma min[12]
Guide Bias	+18V[2]	....	+20V[2] +40V[2]	+20V[2] +40V[2]	+36V[2]	+50±5V[2]	+36V[2]	....	+180V[10] +85V[11]
Bias on output cathode resistor	−20V	....	−20V Zero	−20V Zero	....	....	....	....	....
Forced reset pulse	−120V	−140V	−120V	−120V	−120V	−140V	−120V	−140V	−150V
Double pulse drive-amplitude	−80V±10V	....	−80V±10V	−80V±10V	−80V±10V	−120V±10V	−80V±10V	−100V	....
Double pulse drive-durations	60μS	....	60μS	60μS	60μS	30μS±5μS	60μS	30μS	....
Double pulse drive-drive overlap	....	....	....	....	....	6±2μS	....	....	....
Integrated pulse drive-amplitude	−145V±15V	....	−145V±15V	−145V±15V	−145V±15V	−145V±15V	−145V±15V	....	....
Integrated pulse drive-duration	80μS	....	80μS	80μS	80μS	35±10μS	80μS	....	....
Random pulse drive-amplitude	....	−144V+50V −12V	....	....	....	....	....	....	−160V
Random pulse drive-guide bias	....	+72±12V	....	....	....	....	....	....	....
Random pulse drive-quiescent time	....	25μS Min.[5]	....	....	....	....	....	....	....
Random pulse drive-duration	....	25μS Min.[5]	....	....	....	....	....	....	35μS min.
Sine wave drive-amplitude	40–70V r.m.s.	65–100V r.m.s.	40–70V r.m.s.	40–70V r.m.s.	40–70V r.m.s.	45–100V r.m.s.	40–70V r.m.s.	....	....
Sine wave drive-guide bias	....	+12±2V	....	....	....	....	....	....	....
Cathode load resistors	....	....	....	....	....	33KΩ–68KΩ[8]	....	33-68KΩ[8]	27-39KΩ

Cathode load resistors	....	....	....	....	....	33KΩ–68KΩ(8)	....	33–68KΩ(8)	27–39KΩ

MECHANICAL DATA

Mounting position For visual indication all tubes are viewed through the dome of the bulb	any	any	any	any	any	any	any	any	any
Alignment	Cathode "0" with pin 6 to accuracy of $\pm12°$	Cathode "0" with pin 6 to accuracy of $\pm12°$	Cathode "0" with pin 6 to accuracy of $\pm12°$	Cathode "0" with pin 6 to accuracy of $\pm10°$	Cathode "1" with pin 11 to accuracy of $\pm12°$	Cathode "1" with pin 11 to accuracy of $\pm12°$	Cathode "1" with pin 12 to accuracy of $\pm10°$	....	....
Weight (nominal)	43g	44g	43g	43g	53g	53g	50g	....	....
Bezel used with tube	11807	11807	11807	11832	11808	11808	11885	11807	11807
Base required	I.O.	I.O.	I.O.	I.O.	SO-22	SO-22	SO-22	SO-42	....

PIN CONNECTIONS

Pin 1	Common Cathodes	Common Cathodes	Common Cathodes	Common Cathodes	Output Cathode 0	Output Cathode 0	Output Cathode 0	Output Cathode 6	Output Cathode 5
2	Not used	3rd guides	Cathode "5"	Cathode "6"	9	9	11	5	....
3	1st guides	1st guides	1st guides	1st guides	8	8	10	4	4
4	Anode	Anode	Anode	Anode	7	7	9	Guide 2	Guide 1
5	2nd guides	Not used	2nd guides	2nd guides	6	6	8	3	3
6	Not used	Output Cathode	Cathode "9"	Cathode "11"	5	5	7	....	....
7	Cathode "0"	Output 3rd Guide	Cathode "0"	Cathdoe "0"	4	4	6	2	2
8	Not used	2nd guides	Cathode "3"	Cathode "8"	3	3	5	....	Guide 2
9	....	....	....	....	2	2	4	1	1
10	....	....	....	....	1	1	3	0	0
11	....	....	....	....	2nd guides	2nd guides	2	Routing Guide 1	Guide 3
12	....	....	....	....	1st guides	1st guides	1	Routing Guide 2	9
13	....	....	....	....	....	....	....	9	....
14	....	....	....	....	....	....	....	....	8
15	....	....	....	....	....	....	....	8	....
16	....	....	....	....	....	....	....	7	7
17	....	....	....	....	....	....	....	Guide 1	6
19	....	....	....	....	....	....	....	....	....
20	....	....	....	....	....	....	....	....	....
21	....	....	....	....	....	....	....	Anode	....
22	....	....	....	....	....	....	....	....	....
23	....	....	....	....	....	....	....	....	....
24	....	....	....	....	....	....	....	Anode	....
25	....	....	....	....	....	....	....	....	....
26	....	....	....	....	....	....	....	....	....
27	....	....	....	....	....	....	....	Anode	....
Center Pin	....	....	....	....	....	....	....	....	Anode
Base Cap	....	....	....	....	Anode	Anode	Anode	....	....
Yellow Flying Lead	....	....	....	....	....	....	1st guides	....	....
Green Flying Lead	....	....	....	....	....	....	2nd guides	....	....

NOTES

(1) The required anode current may be obtained from a 475V supply via an 820KΩ resistor.

(2) This does not apply in the case of the sine-wave drive.

(3) The output cathode must not rise above the potential of the common cathodes by more than 10 volts, and may be made more than 30 volts negative only when resetting.

(4) The required anode current may be obtained from a 475V supply via a 330KΩ resistor.

(5) The maximum is limited by the repetition rate.

(6) The required anode current may be obtained from a 475V supply via a 680KΩ resistor.

(7) The required anode current may be obtained from a 475V supply via a 300KΩ $\pm$ 5% resistor.

(8) Cathode with no load resistor should be returned to +18V.

(9) The required anode current may be obtained from a 475V supply via a 910KΩ resistor.

(10) Not counting.

(11) Counting.

(12) Required anode current obtained from 500V via 120KΩ resistor.

GENERAL NOTES: Unused pins must not be used as tie-points or taken to any potential including ground. Minimum anode supply voltages shown are measured at normal room illumination.

Baird-Atomic, Inc.

VOLTAGE REFERENCE TUBES

REMARKS	GD86W/S Reference Tube NB 1	GD85M/S Miniature Reference Tube	GD85WR/S Ruggedized Subminiature Voltage Reference Tube
LIMIT RATINGS			
Minimum anode current	$50\mu a$	1.0ma	0.5ma
Maximum anode current	1.0ma	10.0ma	5.0ma
Minimum supply voltage Normal room illum. 5 to 50 ft. candles	125V	115V	(Or total darkness) 125V
Equilibrium condition reached after	90 sec. operation	3 mins. operation	
Maximum temp. coefficient	(20-100°C) — 5mv/°C		(−60°C to +25°C) — 10mv/°C (+25°C to +85°C) — 7mv/°C
Maximum acceleration 100 hr. periods 10 min. duration			 5.0g 20.0g
Maximum shock (short duration)			750g
CHARACTERISTICS			**AT + 25°C**
Running voltage	86 ± 1.5V at $500\mu a$	85 ± 2V at 6ma	85 ± 2V at 1.5ma
Maximum running voltage			90.5V at 5ma
Recommended current range when used as reference tube	$400\mu a$ — 1ma		
Incremental resistance	$5{,}500\Omega$ (at $400\mu a$—1ma)	450Ω at 6ma	800Ω (@ 1.5ma)
Maximum noise generated by the tube	50-5000 cps at $500\mu a$ $220\mu V$ rms		
Maximum % variation of V_R	first 3000 hrs. at $500\mu a$ — 2%	(1000 hrs. at 6ma) 0.5%	
Typical drift of V_R	0.09% per 1000 hrs. after first 1500	0.1% for 100 hrs. after first 200 at 6ma	at 1.5ma 0 to 100 hrs. ±0.1% 100 to 1000 hrs. ±0.1% 1000 to 10,000 hrs. ±0.1%
Regulation		0.18V at 5.8 to 6.2ma 4.0V at 1 to 10ma	1V at 1 to 2.0ma 4.5V at 0.5 to 5.0ma
Vibration noise — 20g min. at 50 cps 20g min. at 60-2000 cps			25mv p.p. max. 50 mvp.p. max.
Maximum voltage jump		Anode res. 5K 1 to 10ma 100mv peak	8mv peak max., 1.0 to 5.0ma 50mv peak max., 0.5 to 5.0ma
MECHANICAL DATA			
Mounting position	Any	Any	Any
Base	Wire leads Anode marked with red spot	7 pin Miniature	4 wire Flying Leads
Base connections:		1 anode 2 cathode 3 do not connect 4 cathode 5 anode 6 do not connect 7 cathode	1 cathode 2 lead omitted 3 anode 4 L. O. 5 L. O. 6 cathode 7 L. O. 8 anode

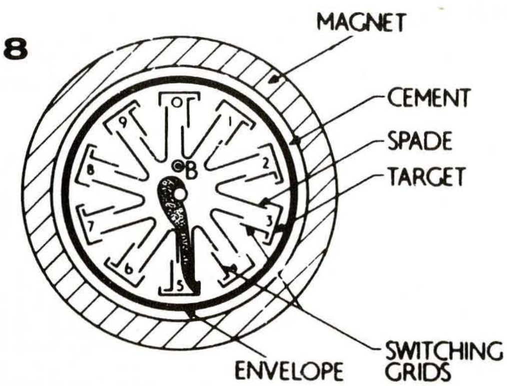
NB 1. There is no step or discontinuity of Ia/Ea curve for currents greater than $400\mu a$

TROCHOTRON® BEAM SWITCHING TUBES

These tubes have been developed to overcome many of the limitations encountered in the use of Dekatron and other counting circuits where maximum counting speeds are limited by components such as gas-filled tubes or by component tolerances. In a Trochotron, an electron is made to travel along equipotential lines under the influence of crossed electric and magnetic fields to a series of stable positions, with very fast switching rates.

These tubes have an indirectly heated cathode surrounded by a symmetrical array of electrodes known as spades, targets and switching grids, as shown in Fig. 8. The spades are associated with the switching action of the tube and form and hold the beam. The switching grids cause changes to occur in the spade characteristics which enables the beam to be transferred from one stable position to the next. The targets, which collect the majority of the beam current have a constant current characteristic, and are used as output electrodes, particularly at high frequencies. A constant, uniform, magnetic field is applied to the tube, parallel to its axis, by a cylindrical magnet cemented to the bulb.

FIG. 8



Section of a Trochotron Showing The Beam formed on Position 5.

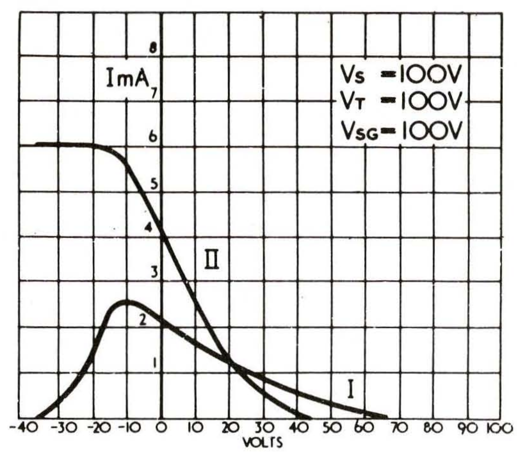
An idealized spade characteristic is shown in curve I, Fig. 9. The remaining spades, the targets and switching grids are held at a nominal positive voltage of +100 volts and the cathode is at 0 volts. As the voltage of a spade is lowered from 100 volts, the current to it increases to a maximum and then falls almost to zero. This particular characteristic is used to achieve the switching and holding of the beam. While the current to the spade is increasing the associated target current is also increasing as shown by curve II. The target current is determined by the spade supply voltage and a typical relationship is shown in Fig.11.

The dynamic characteristic of the tube is shown in Fig.10, curve II. It is also known as the leading spade characteristic, and is obtained by holding one spade at cathode potential and plotting a current/voltage curve of the spade which occupies the adjacent clockwise position. This characteristic decays to a holding spade characteristic during switching, and the now lagging spade recovers at a rate depending on the spade load resistors and capacity.

Referring to Fig.10 again, a load line R_s is shown for a holding spade, intersecting curve I at three points *a*, *b*, and *c*. At *a* the tube is "Cut Off", at *b* the load line intersects a negative slope and the condition is unstable. At *c* the load line intersects a second stable point — the "Beam Formed" condition.

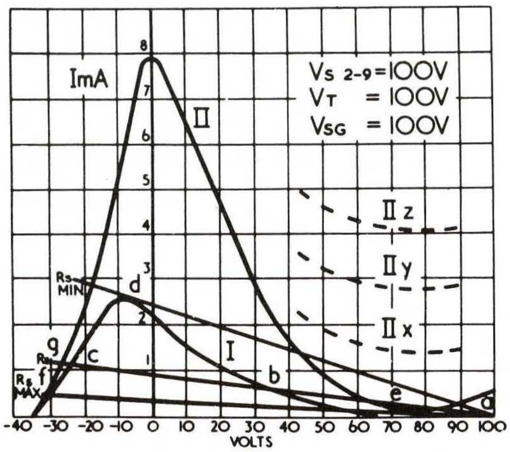
Limiting load lines are drawn at R_s max. and min. In the first case the load line is a tangent to the holding spade characeristic at *d*, a smaller value of load resistor than R_s min. would only intersect the characteristic at *a*, and the beam

FIG. 9



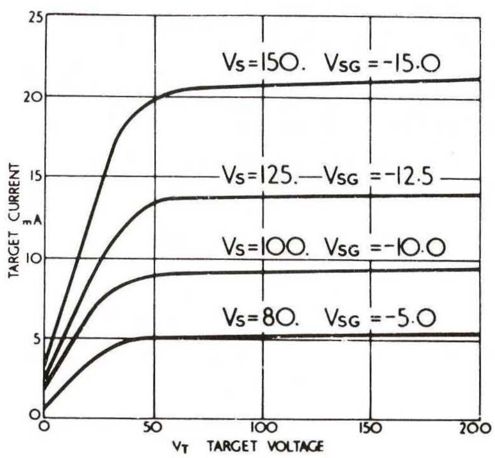
Idealized Spade Characteristic

FIG. 10



Trochotron Holding and Leading Spade Characteristics

FIG. 11



Typical Target Characteristics

would never be formed. The load line R_s max. is a tangent to the leading spade characteristic at *e*, and for values of R_s greater than R_s max. the load line would only intersect the leading spade characteristic at a point below *f* and the beam would always lock on this spade.

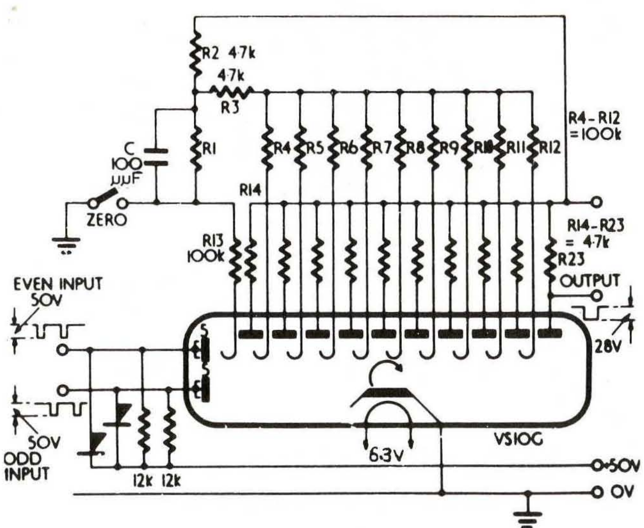
The switching grids are held at a positive voltage normally greater than half the spade supply volts. A result of lowering the switching grid voltage is to raise the tail of the leading spade characteristic. Curves II *x*, *y*, and *z* represent successive lowering of the voltage to cathode potential. Under these conditions the load line R_s will only intersect Curve II at *g* and the beam will transfer to the next position.

If the switching grids are held at 0 volts, the beam will continue to rotate at frequency primarily determined by the spade time constant, where the capacitance is that of a spade to earth and the resistance the spade load resistor. To prevent self-switching occurring with very long pulses the switching grids are alternately connected inside the tube into two groups of five, designated ODD and EVEN. The even switching grids are associated with an even spade and initiate the switching to an odd spade and vice versa. The switching grids can thus conveniently be driven by a bi-stable circuit or push pull sinewave drive.

Fig.12 shows a typical operating circuit for a trochotron. In this particular circuit the 100V spade supply produces a target current of 6 mA and with 4.7kΩ target resistors a 28 volt output is produced.

At the instant of switching on supplies, the tube will be cut off and in order to form and lock the beam it is necessary to lower the zero spade supply voltage to approximately the cathode potential. If the beam is formed on a target other than zero and it is desired to reset, the tube must

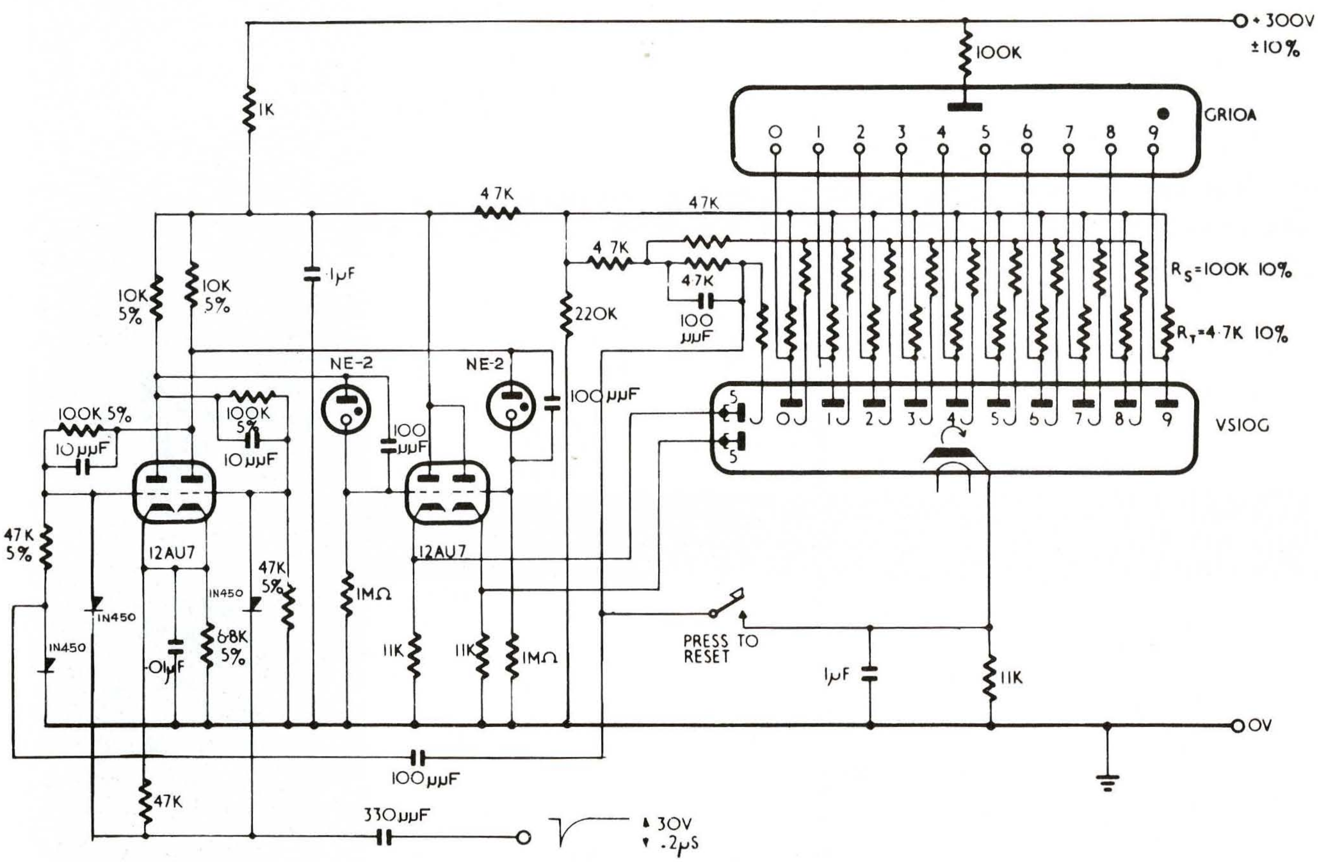
FIG. 12



Typical Operating Circuit for a Trochotron

be returned to the cut off condition and the beam reformed on the zero or desired position.

The circuit shown in Fig.12 illustrates one method of performing both of these functions at once. Operation of the "zero" switch instantaneously reduces all the spade voltages to cathode potential. If a beam was previously formed, this returns the tube to the cut off state. Spades 1-9 recover to a fraction of the spade supply voltage $\frac{R1}{R1 + R2}$ with a very short time constant. Spade zero is held at cathode potential and the beam forms on this electrode. On releasing the zero switch the spades 1-9 return to the spade supply voltage instantaneously and the zero spade return is delayed by the capacitor 'C', thus ensuring that the beam remains formed in the zero position. The resistor R_3 is included to ensure that all spades have the same effective supply voltage.



LK 125

FIG. 13 **1Mc/s Trochotron Decade Counter with GR10A Register Tube Readout**

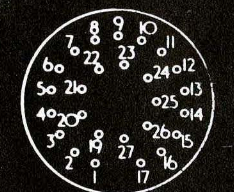
Baird-Atomic, Inc.

TROCHOTRON SPECIFICATIONS

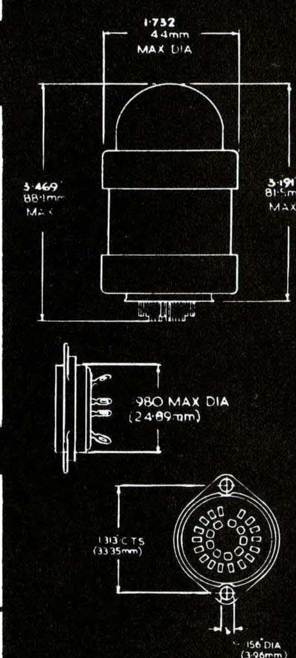
		VS10G	VS10H
COLOR CODE		Red	Yellow
MAX. SWITCHING SPEED		1 Mc/s	2 Mc/s
CATHODE		Indirectly heated	Indirectly heated
HEATER	Vh	6.3V	6.3V
	Ih	0.55A	0.55A
LIMIT RATINGS			
Maximum heater to cathode voltage		±150V	±150V
Maximum spade to cathode voltage (V_S max.)		125V	140V
Minimum spade to cathode voltage (V_S min.)		80V	80V
Minimum target to cathode voltage (V_T min.)		50V	50V
Maximum target to cathode voltage (V_T max.)		300V	200V
Minimum Switching-grid to cathode voltage (V_{SG} min.)	V_S = 125V	55V	55V
	V_S = 80V	45V	45V
Minimum spade resistor (R_S min.)	V_S = 100V	75kΩ	75kΩ
Maximum spade resistor (R_S max.)	V_S = 100V	130kΩ	130kΩ
Minimum input duration		0.5μs	0.25μs
(Pulse amplitude should be sufficient to bring the switching grid potential to 5V below the cathode voltage.)			
CHARACTERISTICS			
Holding spade current		1.0ma nom.	
Target current	V_S = 125V	10.0ma nom.	
	V_S = 100V	7.5ma nom.	
	V_S = 80V	6.5ma nom.	
	V_S = 140V		18ma max.
Switching-Grid current on switching			
	V_S = 125V	1.0ma max.	
	V_S = 100V	0.4ma max.	
	V_S = 80V	0.2ma max.	
RECOMMENDED OPERATING CONDITIONS			
	V_S	100V	140V
	R_S	100kΩ	100kΩ
(Each spade must be connected to a separate load resistor with not more than ½″ of connecting lead.)			
	V_T	100V	140V
	R_T	4.7kΩ	2.2kΩ
(Any number of target connections may be taken to a common target resistor.)			
	V_{SG}	50V	65V
	V_{SG} pulse amplitude	−55V	−70V
	Trigger pulse	0.5μs	0.25μs
MECHANICAL DATA			
Mounting position: Any: providing that the tube is kept at least 2″ from any magnetic material or 4″ from a similar tube, a strong magnet or a mu-metal screen.			
Weight		185g	185g
Base		S042	S042

VS10G & VS10H MECHANICAL DATA (Contd.)

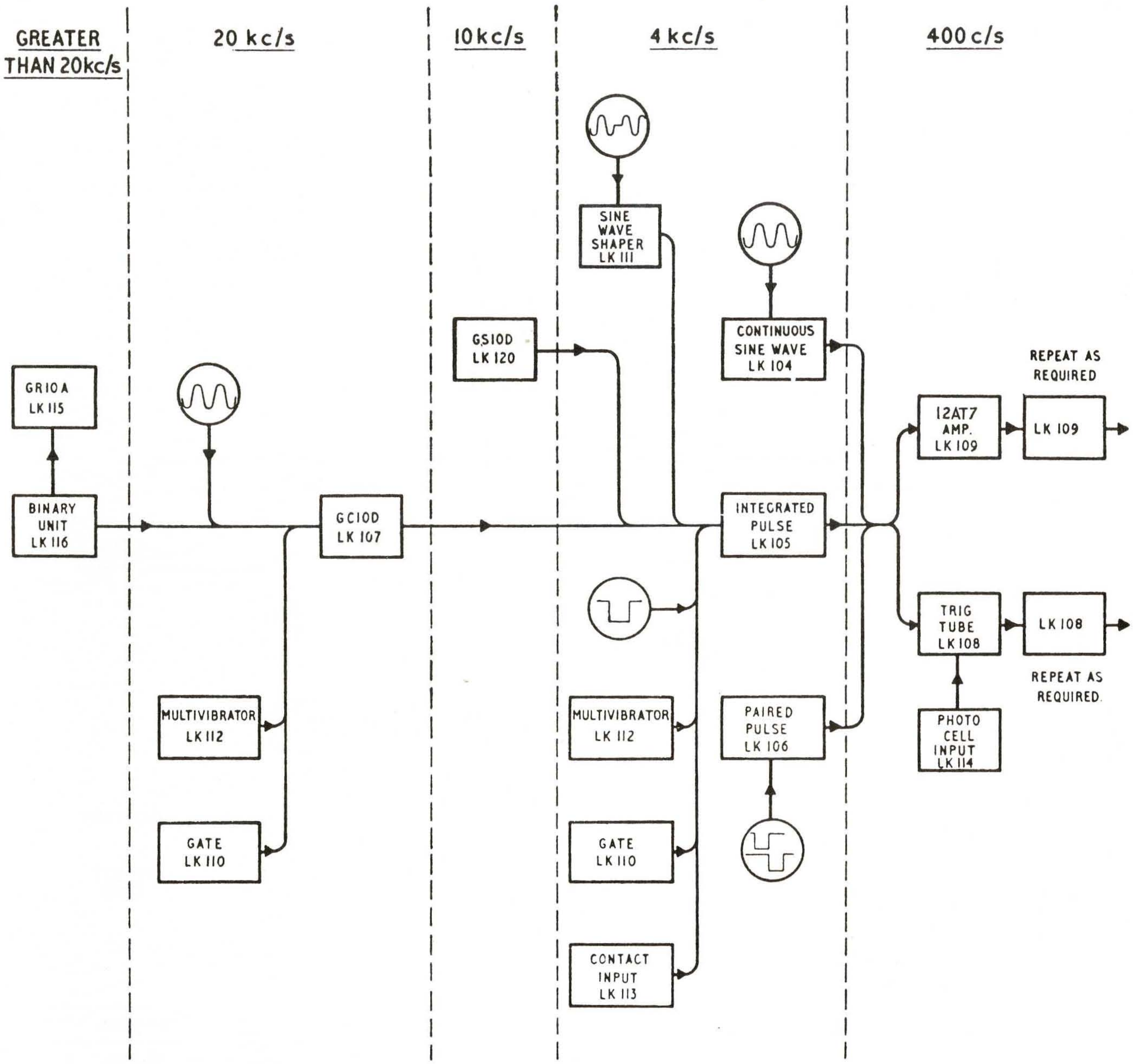
BASE CONNECTIONS
(Underside View)



Pin	
1	Spade 0
2	Target 9
3	Target 8
4	Odd Switching grids
5	Target 7
6	Spade 7
7	Target 6
8	Target 5
9	Spade 5
10	Target 4
11	DO NOT CONNECT
12	Target 3
13	Target 2
14	Spade 2
15	Target 1
16	Even Switching grids
17	Target 0
19	Spade 9
20	Spade 8
21	Heater
22	Spade 6
23	Spade 4
24	Spade 3
25	Heater
26	Spade 1
27	Cathode

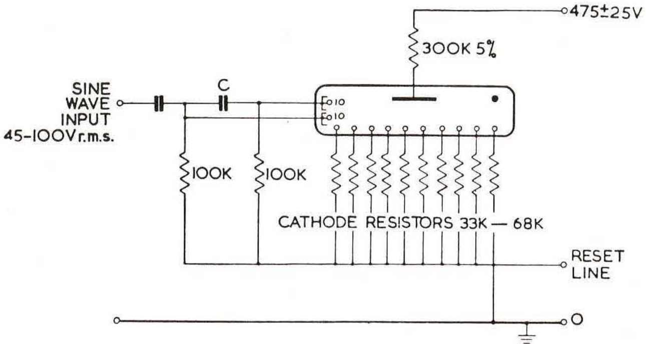


Circuit Index



LK121

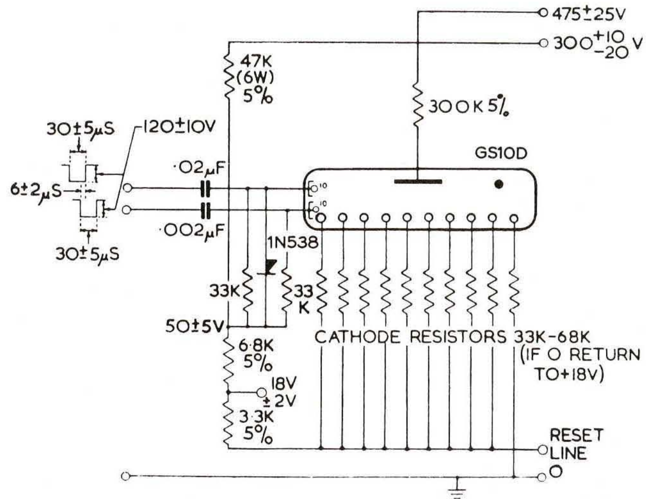
Continuous Sine-Wave Drive



LK100

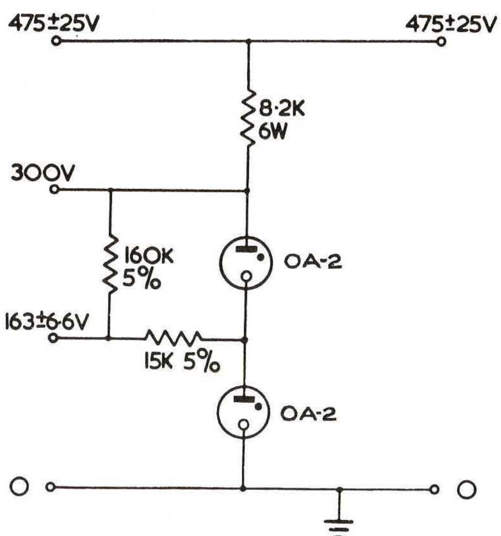
Frequency	20 Kc/s	15 Kc/s	10 Kc/s	5 Kc/s	2 Kc/s	1 Kc/s	500 c/s	200 c/s	100 c/s	50 c/s
C	270 μμF	330 μμF	470 μμF	680 μμF	.002 μF	.005 μF	.01 μF	.02 μF	.05 μF	.1 μF

Paired-Pulse Drive



LK102

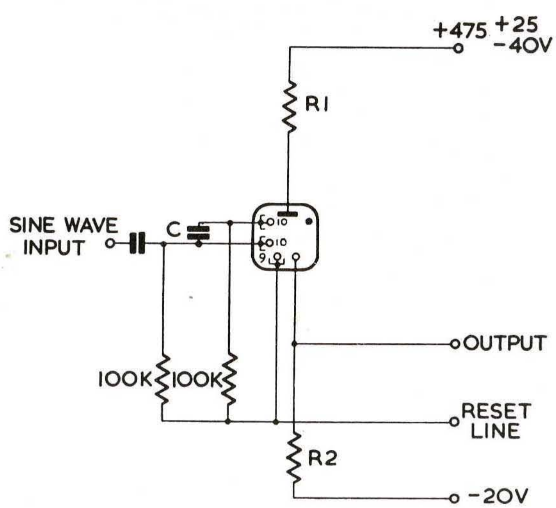
Stabilized Voltage Supplies for use with Dekatron Circuits



LK103

The above circuit uses two OA-2 tubes to provide a stabilized +300 V supply from +475 V. The +163 V supply is used for trigger bias with GTE.175M trigger tubes.

Continuous Sine-wave Drive for 4 kc/s Dekatron

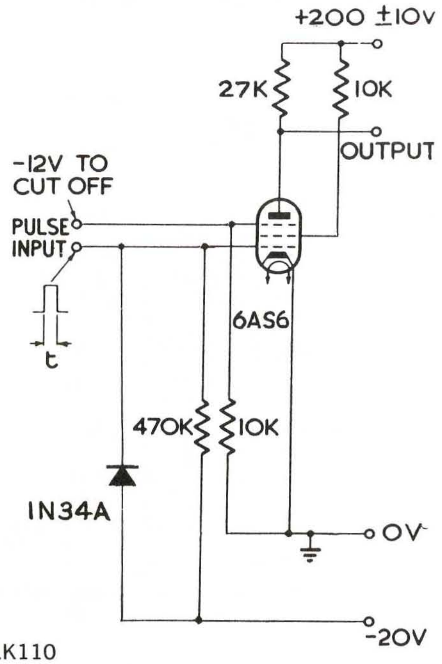


LK104

	Counters	Selectors
R1	820 kΩ	680 kΩ
R2	150 kΩ max.	150 kΩ max.

Frequency	4 kc/s	2 kc/s	1 kc/s	500 c/s	200 c/s	100 c/s	50 c/s
C	680μμF	.002 μF	.005 μF	.01 μF	.02 μF	.05 μF	.1 μF
Drive Amplitude	40 — 70 V r.m.s.						

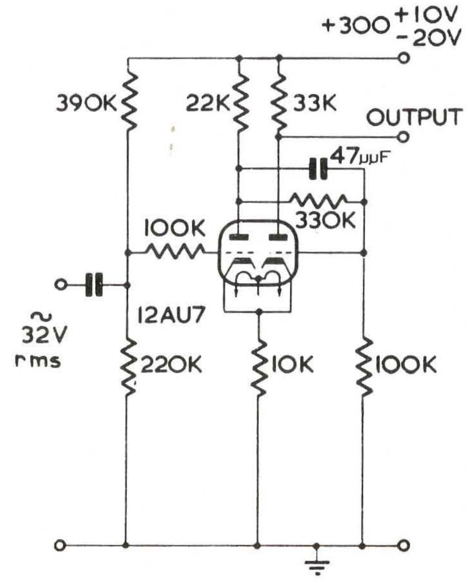
Gate Circuit for use with Single and Double-pulse Dekator Drive Circuits



LK110

GC10D	GS10D	4 kc/s Dekatron
25 μS	35 μS	80 μS
Pulse Amplitude > +20 V		

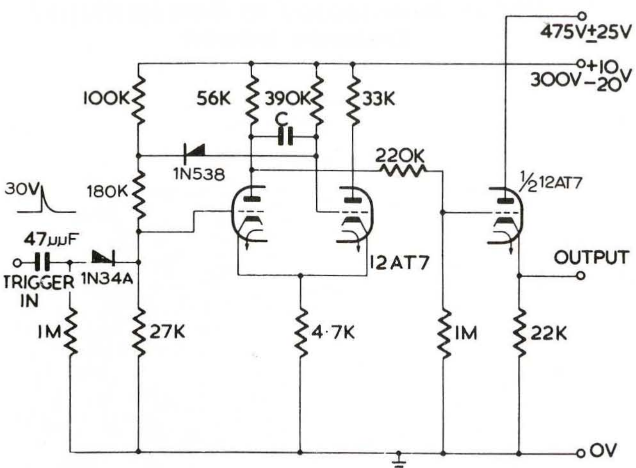
Sine-wave Shaping Circuit



LK111

In the continuous sine-wave drive circuit LK.104 the correct phase relationship is not achieved until a few cycles have elapsed. In order to count trains of sine-waves it is necessary to convert them into pulses suitable for the integrated pulse drive LK.105. The above circuit fulfils this requirement.

Multivibrator Pulse Shaping Circuit

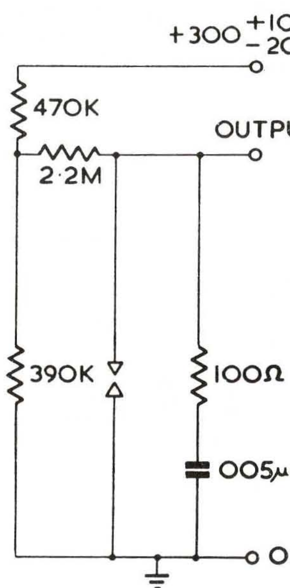


Output Pulse	C
25 μS 80 μS	100 $\mu\mu$F 470 $\mu\mu$F

LK112

The above circuit is designed to feed either the integrated pulse drive LK.105, or the GC10D single pulse drive LK.107. Triggering is achieved with a short positive pulse of amplitude greater than 30 V.

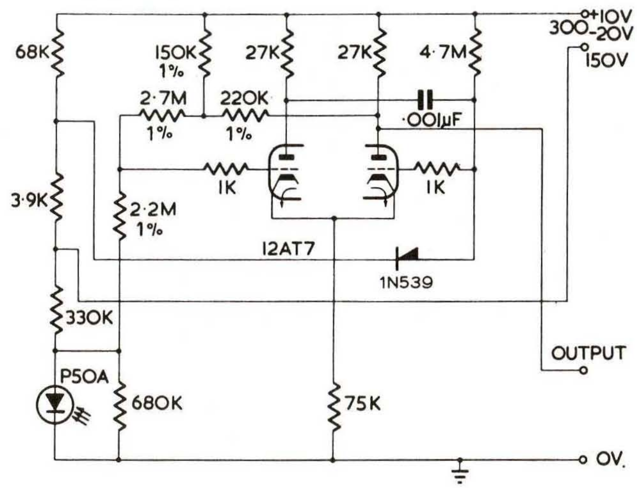
Contact Input



LK113

In order to prevent spurious counting due to contact bounce, it is essential to precede the integrated pulse drive LK.105 with a quenching circuit.

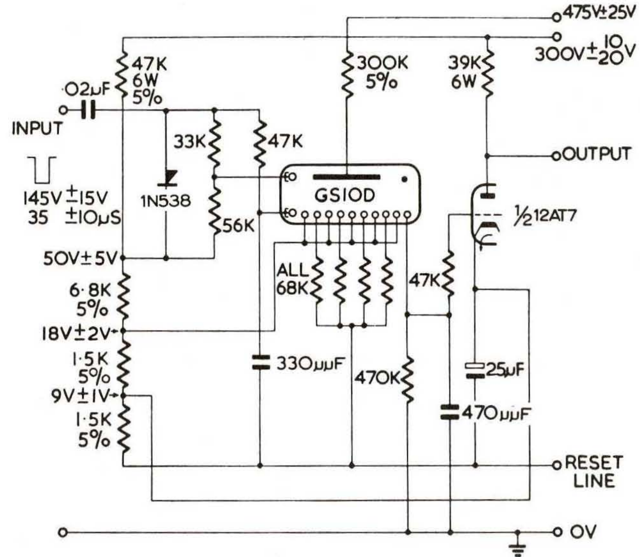
Photo-cell Input for 4 kc/s Dekatron



LK114

This circuit has been designed for use with a P50A, germanium junction photo-cell. A positive going pulse is produced at the output whenever the light focused on the cell is interrupted. This pulse is suitable for driving the cold-cathode coupling circuit LK.108. The 150 V supply rail should be stabilized and may be obtained from the stabilizing circuit LK.103.

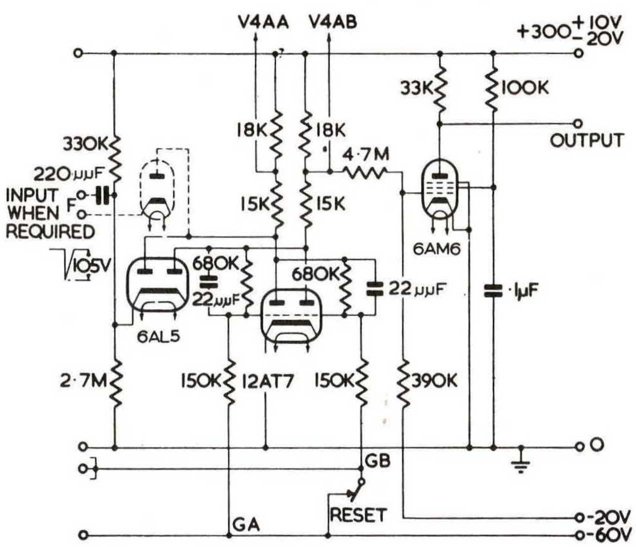
Coupling Circuit from GS10D to GS10C or other 4 kc/s Dekatron



LK120

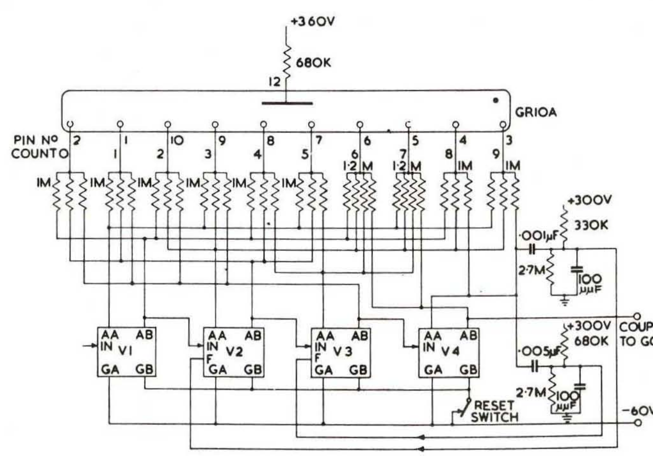
The grid and cathode of the pulse amplifier are used as a limiting diode for the GS10D output cathode voltage.

Detail of Binary Counting Stage with Pulse Amplifier for Driving GC10D Circuit LK107



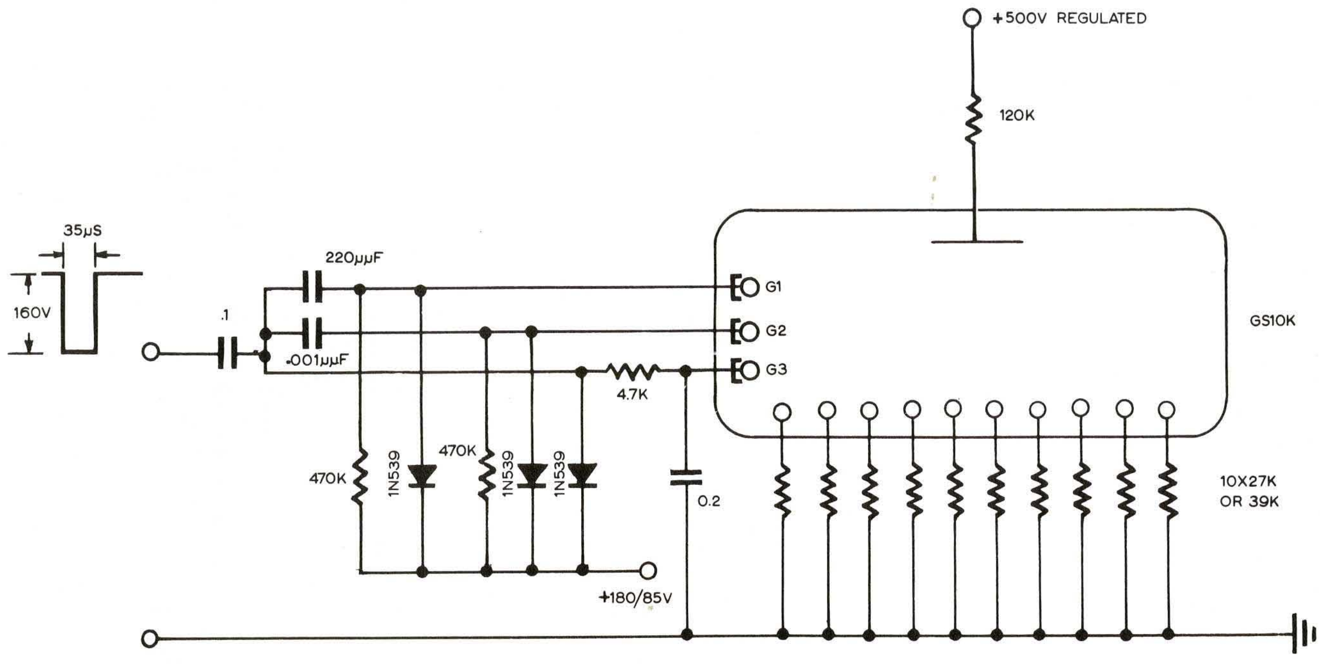
LK116

GR10A Connected to Conventional Decade Scaler



LK115

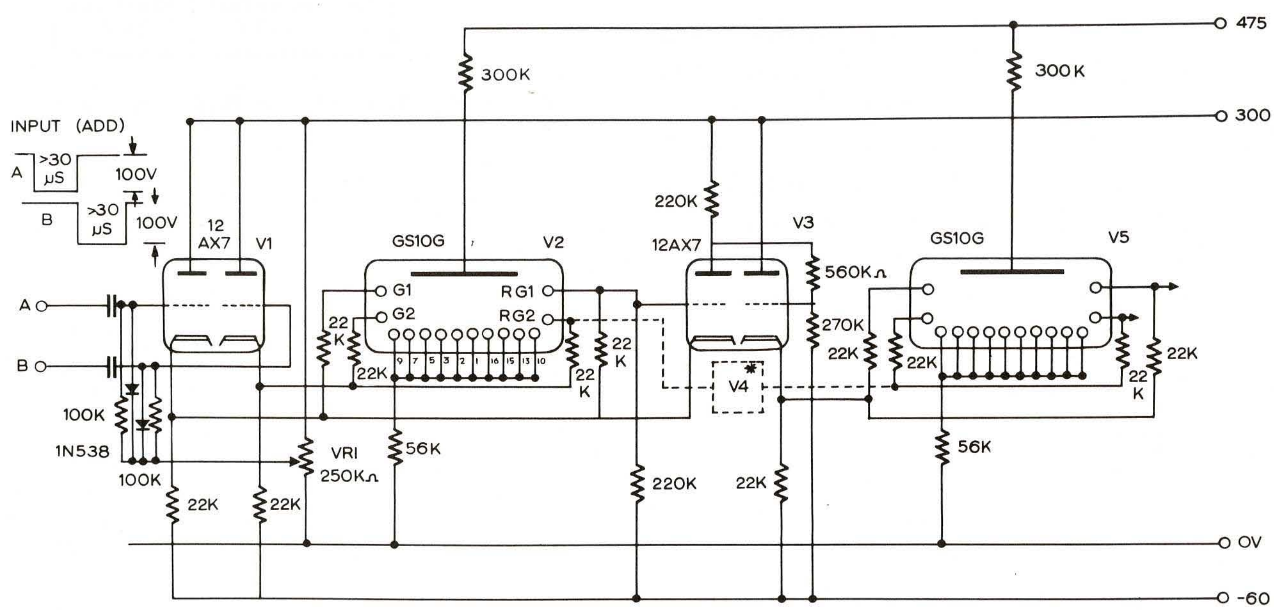
Input Circuit for High Current Dekatron GS10K



Note: Bias should be +180V when not counting, +85V when counting.

Note: The clamping diode on the guide line must stand a P.I.V. of 250V.

Coupling Between two GS10G Reversible Counters



*V4 circuitry is identical to that for V3.

VR1 should be set at 40V. to ground.

Note: Reverse sequences of pulses for subtract operations.

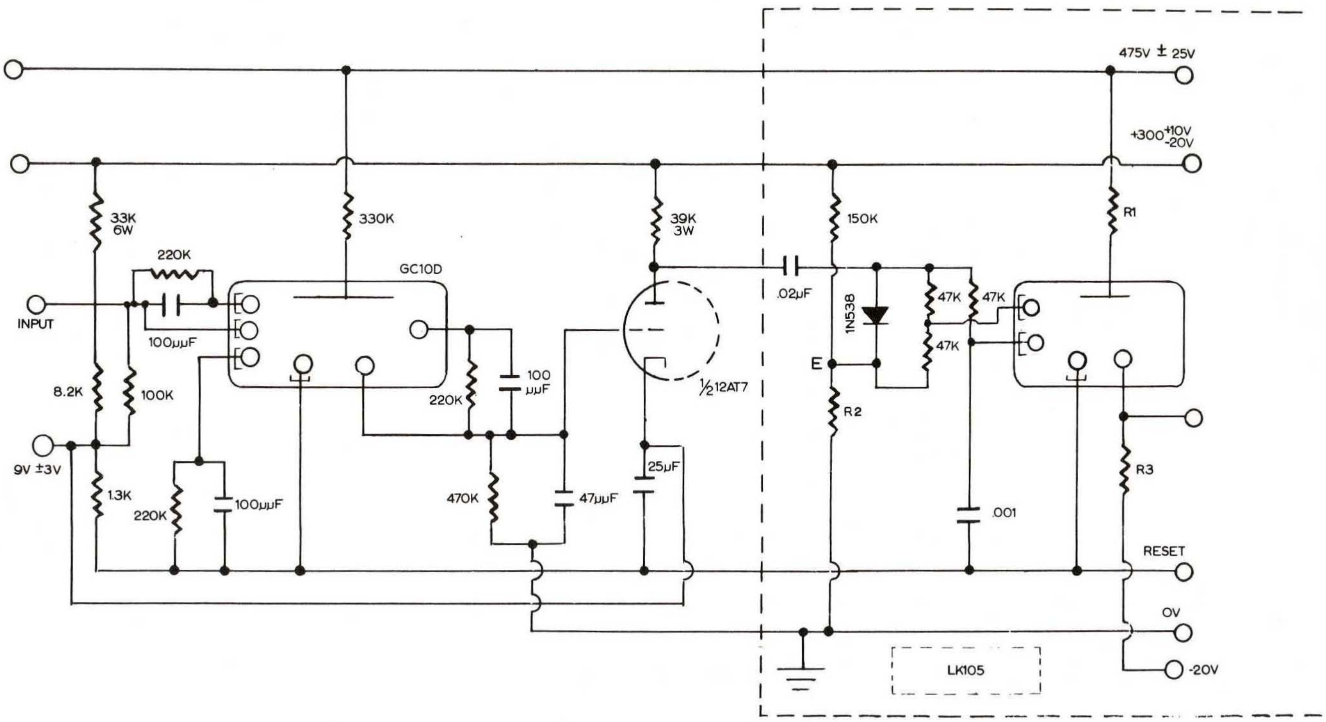


FIG. 14 LK105

	Counters	Selectors
R1	820 kΩ	680 kΩ
R2	10 kΩ	22 kΩ
R3	150 kΩ max.	150 kΩ max.
E	+18 V	+36 V

$V_P = -145 \pm 15$ V $t_1 = > 80$ μS $t_2 = > 170$ μS

. . . illustrates a simple device for dividing a standard signal source frequency by powers of ten.

It is possible to replace the GC10B tube by a selector type, such as the GS10C, connect the 0 and 5 cathodes together through a 150 K resistor to ground and produce two output pulses for each 10 input pulses. This is essentially division by a factor of five. In a similar manner it is possible to divide by the following factors:

Tube Type	*Factors*
GS10C	1, 2, 5, 10
GS10D	1, 2, 5, 10
GS12D	1, 2, 3, 4, 6
GC12/4B	1, 2, 3, 4, 6

It is also possible to detect the output from any of the ten or twelve cathodes of the selector Dekatrons, operate a relay to reset the tube automatically and thereby divide by any factor (including 7, 8, 9 and 11).

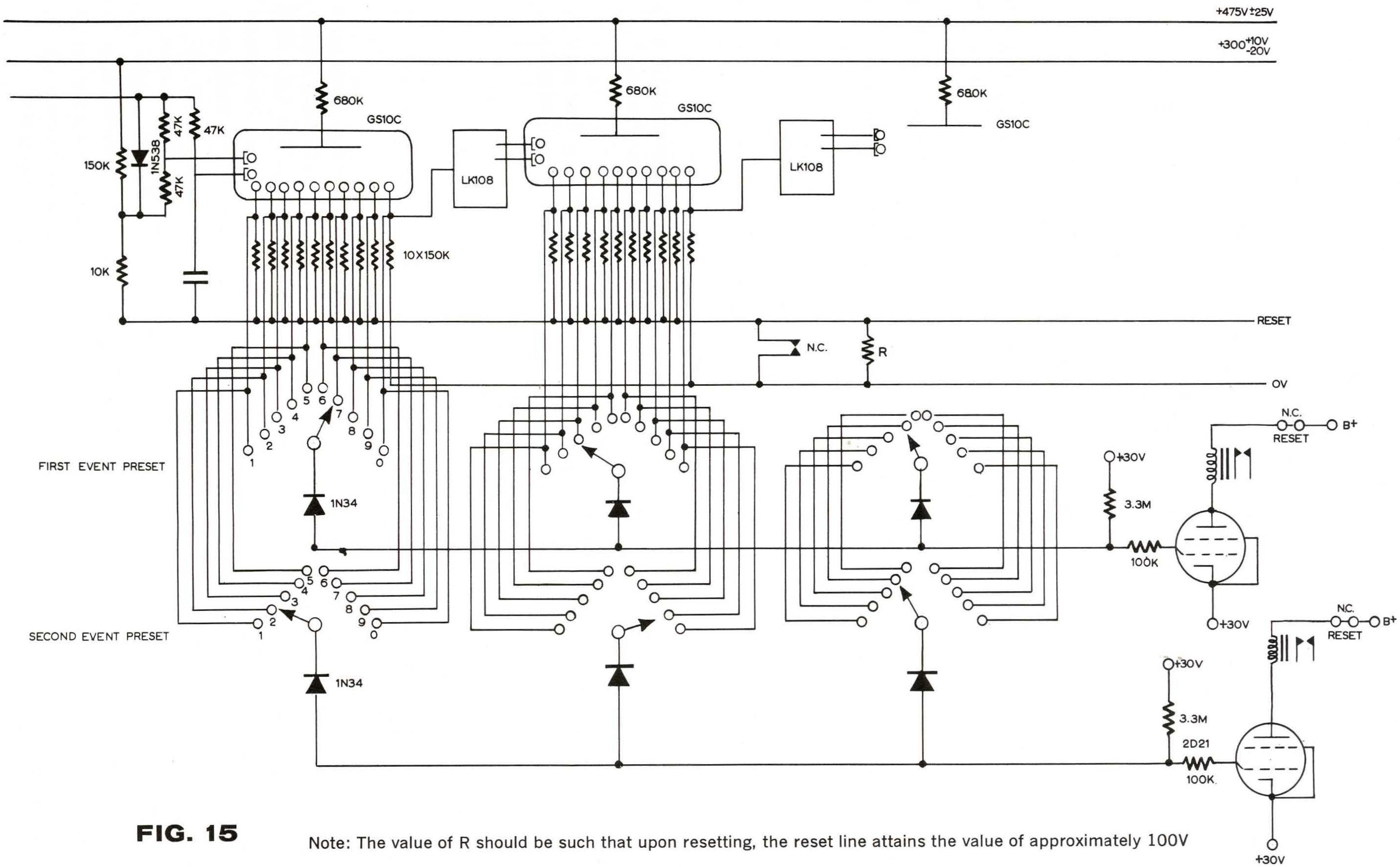
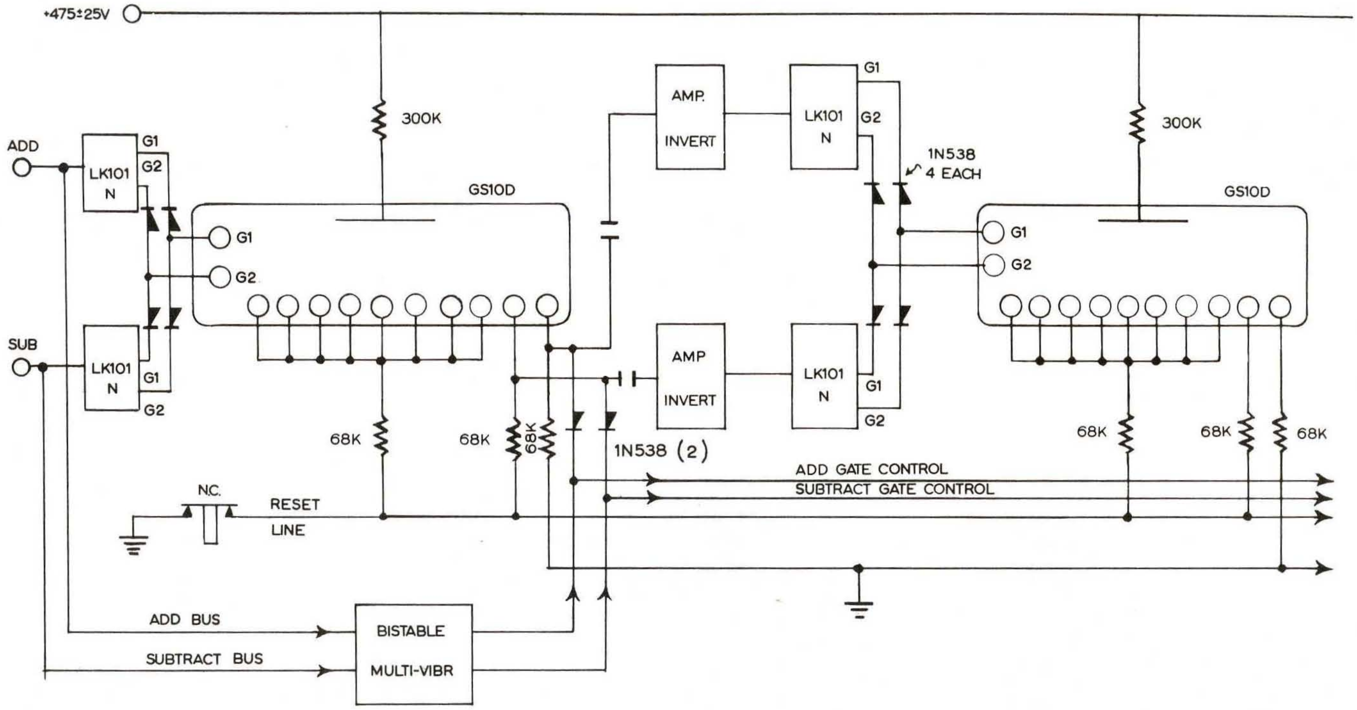


FIG. 15

Note: The value of R should be such that upon resetting, the reset line attains the value of approximately 100V

. . . illustrates a standard preset counter. This counter circuit is designed to provide a dual preset capability, although it may be extended to include any number of preset events. At coincidence the grid bias voltage is caused to change from approximately —30V to 0V. At that time the 2D21 strikes and the relay energizes. A switch is provided in series with each relay circuit to cut off the thyratron when desired, usually at reset.



Pulse from ADD BUS { Add Gate Control = +40v
Sub. Gate Control = 0v

Pulse from SUB. BUS { Add Gate Control = 0v
Sub. Gate Control = +40v

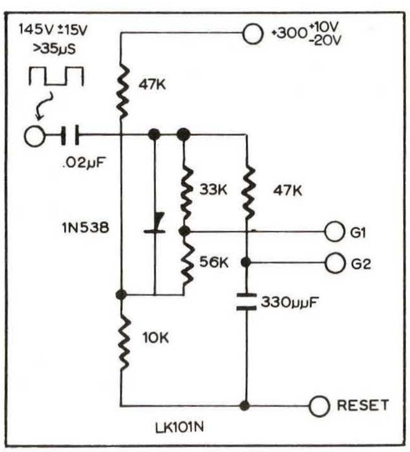


FIG. 16

. . . illustrates the circuit configuration required for random add-subtract operations. The add and subtract bus lines controlled by a bistable multi-vibration circuit are required to control the add-subtract configurations of the guide circuits. They also serve to block the output developed across the cathode "9" series resistors in additive operations and the cathode "0" resistor during subtractive operations. It is necessary to use maximum speed tubes in all decades since each digit may be required to switch at maximum speed during subtraction from 10,000 to 9,999.

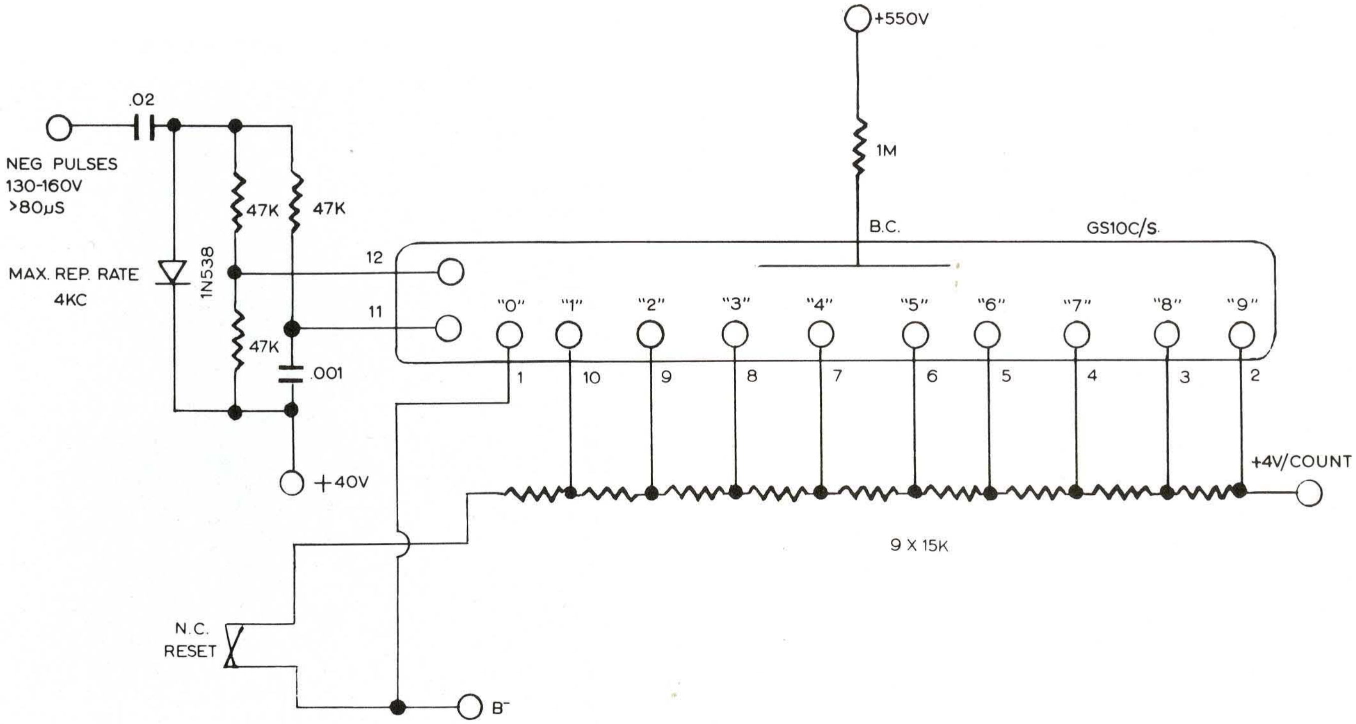


FIG. 17

The selector type Dekatrons, such as the type GS10C/S, may be used to produce a selectable voltage "stair-case." The circuit shown above will produce ten voltage steps of increasing magnitude to a maximum of approximately 35 v. This capability may be used to best advantage in certain automatic control operations sensitive to voltage differences in which the tube is essentially a digital to analogue converter.

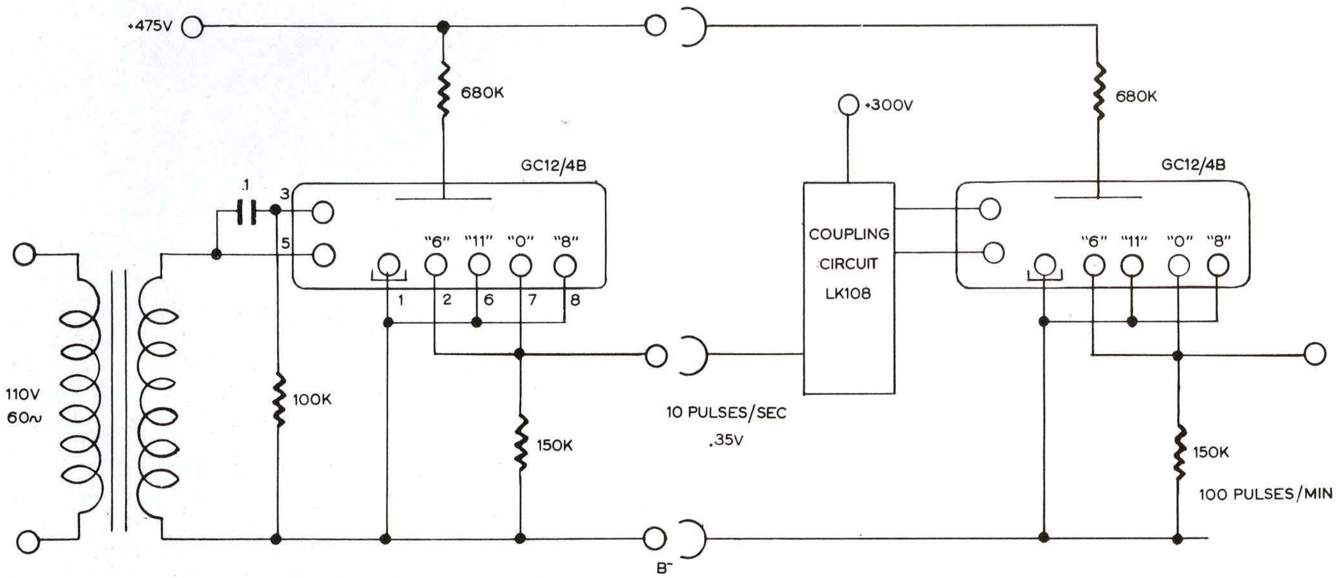
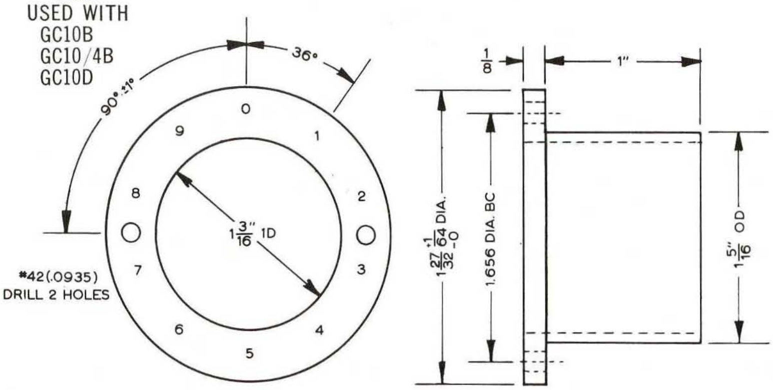


FIG. 18

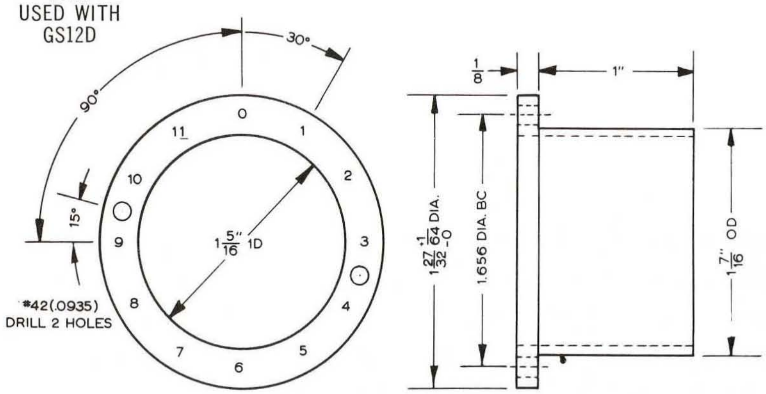
. . . demonstrates a circuit for producing accurate timing pulses from 60 cycle line current. The first GC12/4B is arranged such that output pulses are developed at counts 6 and 12. In this case there are 2 output pulses for each 12 input pulses, 10 for 60 input pulses and therefore the output is 10 pulses per second. This may be used as an input for a second GC12/4B, connected in a similar manner, to produce 100 pulses/minute.

Light Shields and Bezels

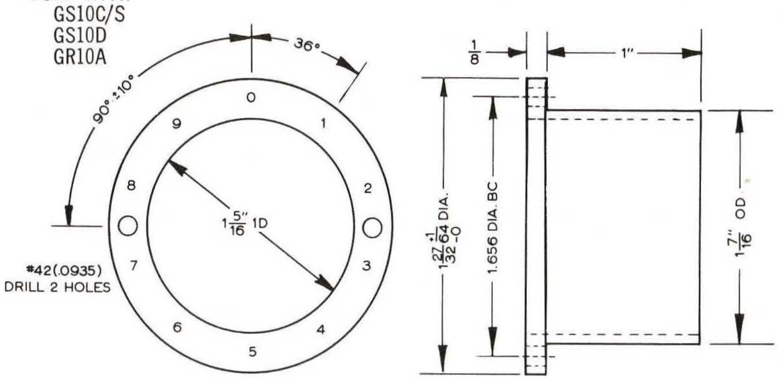
11807
USED WITH
GC10B
GC10/4B
GC10D



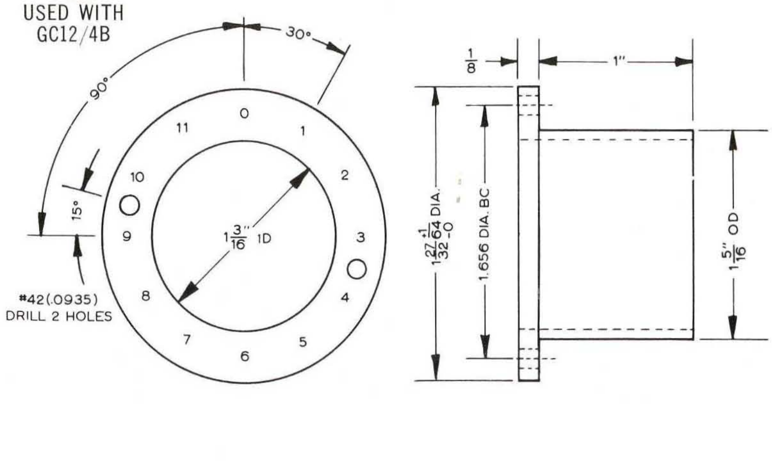
11885
USED WITH
GS12D



11808
USED WITH
GS10C/S
GS10D
GR10A

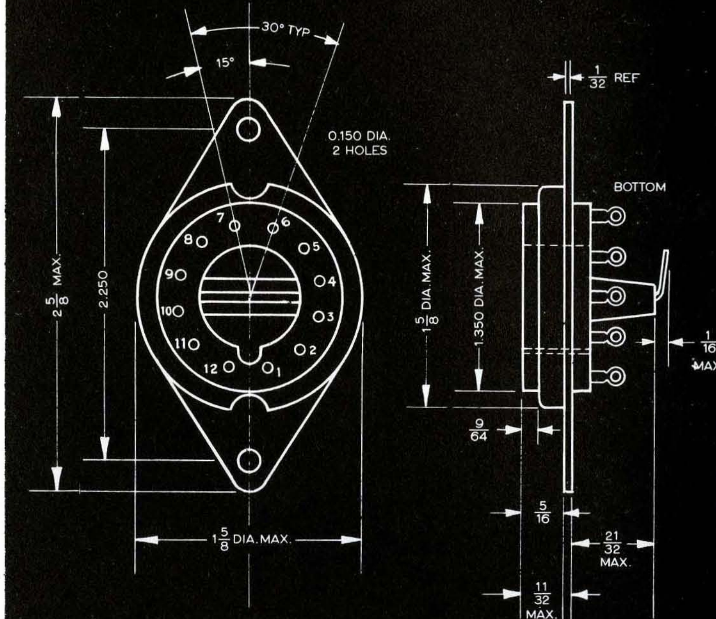


11832
USED WITH
GC12/4B

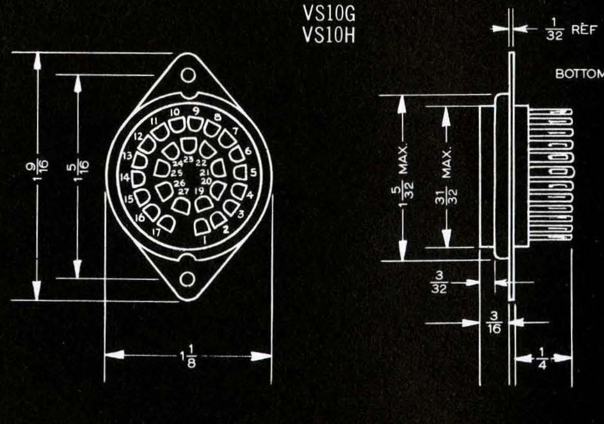


Special Tube Sockets

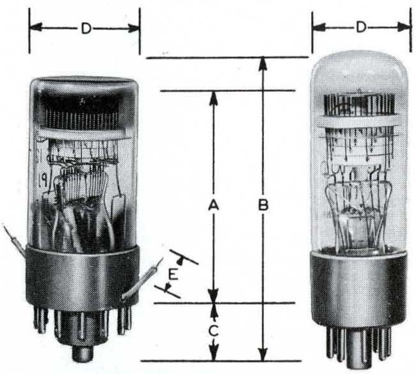
SO-22
USED WITH
GS10D
GS12D
GS10C/S



SO-42
USED WITH
GR10G
GR4G
GR2G
GS10G
VS10G
VS10H



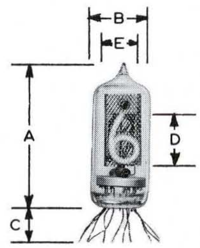
TUBE DIMENSIONS

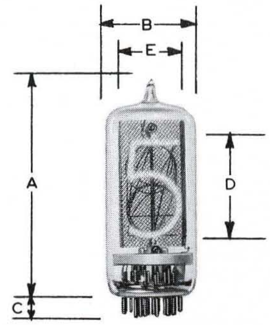


	A	B	C	D	E
GC10B	2.85	3.35	0.58	1.16	—
GC10/4B	2.85	3.35	0.58	1.16	—
GC12/4B	2.85	3.35	0.58	1.16	—
GC10D	2.75	3.35	0.58	1.16	—
GS10C/S	2.28	2.64	0.85	1.30	—
GS10D	2.28	2.64	0.85	1.30	—
GS12D	2.28	2.64	0.85	1.30	1.26
GR10A	2.28	2.64	0.59	1.30	—

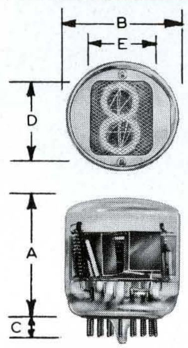
All dimensions shown in inches.

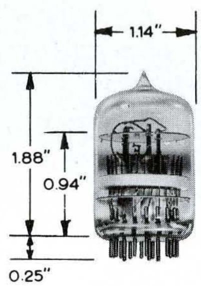
	A	B	C	D	E
GR10G	2.75	1.14	0.25	1.16	0.78
GR2G	2.75	1.14	0.25	0.69	0.81
GR4G	2.75	1.14	0.25	1.16	0.75
GR10W	1.81	0.66	1.50	0.56	0.38
GR10H	1.25	1.22	0.25	0.75	0.66

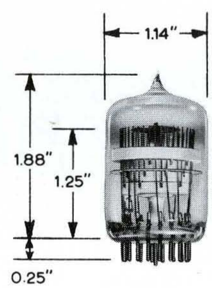


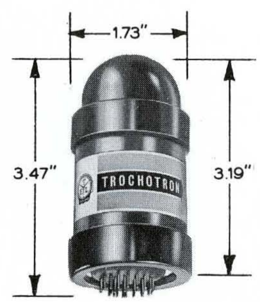


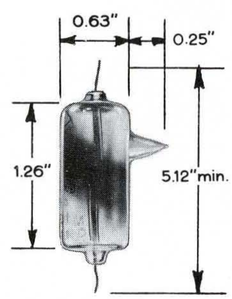
All dimensions shown in inches.



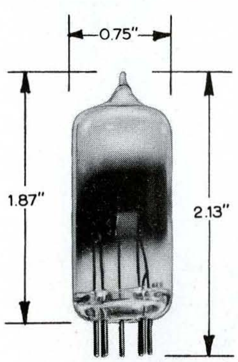


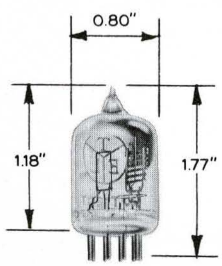


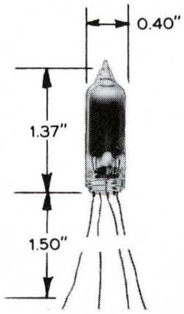


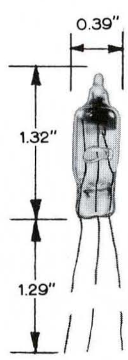


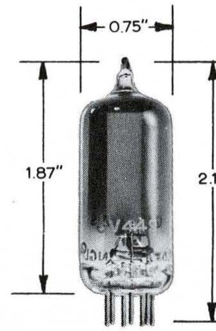
GR10H | GS10G | GS10K | VS10G & VS10H | GD86W/S











GTE175M | GDT120T | GD85WR/S | GTR120W | GD85M/S

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			Quantity (each)						
Dekatron Tubes	**(Bezels + Sockets)**		**1–24**	**25–99**	**100–499**	**500–999**	**1000–2999**	**3000–4999**	**5000+**
GC10B	(a)		$12.10	$10.50	$ 9.45	$ 8.95	$ 8.65	$ 7.77	$ 7.35
GC10/4B	(a)		12.65	11.00	9.90	9.35	9.10	8.14	7.70
GC10D	(a)		14.95	13.00	11.70	11.05	10.75	9.62	9.10
GC12/4B	(c)		14.40	12.50	11.25	10.65	10.30	9.25	8.75
GS10C/S	(b)	(e)	14.95	13.00	11.70	11.05	10.75	9.62	9.10
GS10D	(b)	(e)	17.25	15.00	13.50	12.75	12.40	11.10	10.50
GS12D	(d)	(e)	17.25	15.00	13.50	12.75	12.40	11.10	10.50
GS10G	(a)	(f)	22.75	19.75	17.75	16.75	16.25	14.62	13.83
GS10K	(a)	(h)	22.75	19.75	17.75	16.75	16.25	14.62	13.83
Digitron Register Tubes									
GR10A	(b)	(e)	11.50	10.00	9.00	8.50	8.25	7.40	7.00
GR10G		(f)	10.95	9.55	8.60	8.15	7.85	7.07	6.68
GR10W			12.65	11.00	9.90	9.35	9.10	8.14	7.70
GR2G		(f)	12.65	11.00	9.90	9.35	9.10	8.14	7.70
GR4G		(f)	12.65	11.00	9.90	9.35	9.10	8.14	7.70
GR10H		(g)	18.75	16.25	14.60	13.80	13.40	12.00	11.35
Trochotron Beam Switch Tubes									
VS10G		(f)	70.25	61.50					
VS10H		(f)	92.95	80.80					
Trigger + Voltage Reference Tubes									
GTE175M			3.25	2.80	2.55	2.40	2.35	2.07	1.96
GTR120W			1.05	1.05	0.75	0.75	0.65	0.55	0.50
GDT120T			2.90	2.50	2.25	2.15	2.10	1.85	1.75
GD85WR/S			11.85	10.30	9.30	8.75	8.50	7.62	7.21
GD86W/S			7.15	6.20	5.60	5.30	5.15	4.60	4.34
GD85M/S			3.25	2.80	2.55	2.40	2.35	2.07	1.96
Bezels									
a. 11807			1.15	1.00	0.90	0.85	0.83	0.74	0.70
b. 11808			1.15	1.00	0.90	0.85	0.83	0.74	0.70
c. 11832			1.15	1.00	0.90	0.85	0.83	0.74	0.70
d. 11885			1.15	1.00	0.90	0.85	0.83	0.74	0.70
Sockets									
e. SO-22			0.80	0.70	0.65	0.60	0.58	0.52	0.49
f. SO-42			1.15	1.00	0.90	0.85	0.83	0.74	0.70
g. SO-61			1.15	1.00	0.90	0.85	0.83	0.74	0.70
h. SO-64			1.15	1.00	0.90	0.85	0.83	0.74	0.70

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